City of Riverside

WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

VOLUME 4: WASTEWATER TREATMENT SYSTEM
CHAPTER 7: SECONDARY TREATMENT

FINAL
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City of Riverside

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CHAPTER 7: SECONDARY TREATMENT

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SECONDARY TREATMENT

7.1 PURPOSE

The purpose of this chapter is to summarize the evaluation of the existing secondary treatment facility at the City of Riverside (City) Regional Water Quality Control Plant (RWQCP). This chapter also includes a description of additions or modifications required for Secondary Treatment Facilities to increase capacity to 52.2-mgd annual average (AA) flow.

7.2 RECOMMENDATIONS AND CONCLUSIONS

- The existing treatment system was evaluated and the plant capacity is 40-mgd AA.
- Four options for expanding the RWQCP secondary treatment plant were considered: Conventional Activated Sludge (CAS), Enhanced Primary Treatment (EPT), Membrane Bioreactor (MBR), and Integrated Fixed Film Activated Sludge (IFAS).
- EPT reduced the aeration influent biochemical oxygen demand (BOD) such that denitrification is affected and no increase in capacity is achieved. EPT therefore is not feasible for increasing the secondary treatment capacity.
- CAS, MBR, and IFAS options can all achieve the required expanded capacity. The IFAS option presents more risks than the other alternatives due to the limited experience and number of installations using this technology.
- For meeting current effluent limits, CAS is the most cost-effective alternative followed by IFAS.
- For meeting current effluent limits plus improved Whole Effluent Toxicity (WET) results and better Endocrine Disrupting Compounds (EDCs) destruction, the life-cycle costs for all options are nearly the same, within the uncertainty of the cost estimate.
- Based on the ability to achieve better effluent quality, the City chose the MBR alternative for the future expansion at a meeting on November 17, 2006.
- The current influent flow to the RWCP is approximately 80 percent of the plant's rated capacity, indicating a need for expansion. However, because of a slow down in the housing market, the City has decided to perform this expansion in two phases. The first phase will expand the Plant 1 secondary treatment facilities from 20 to 26-mgd AA. The second phase will expand the secondary facilities from 26 to 32 mgd.

7.3 DESCRIPTION OF EXISTING TREATMENT

Figure 7.1 shows the flow schematic of the existing facilities. The influent wastewater stream is divided into two plants (Plant 1 and Plant 2) after screening and grit removal.

In both Plant 1 and Plant 2, wastewater is clarified in primary clarifiers before biological treatment. Plant 1 has four rectangular aeration basins and four rectangular secondary clarifiers, and Plant 2 has six rectangular aeration basins and four circular secondary clarifiers. For a detailed description of the existing facilities, refer to Volume 4, Chapter 1 - Description of Existing Facilities. The description of facilities for handling waste solids generated during the wastewater treatment process is discussed separately in Volume 8, Chapter 1 - Biosolids Management: Existing Facilities. The design criteria for the solids handling facilities are discussed in Volume 8, Chapter 3 - Biosolids Management: Design Criteria Development.

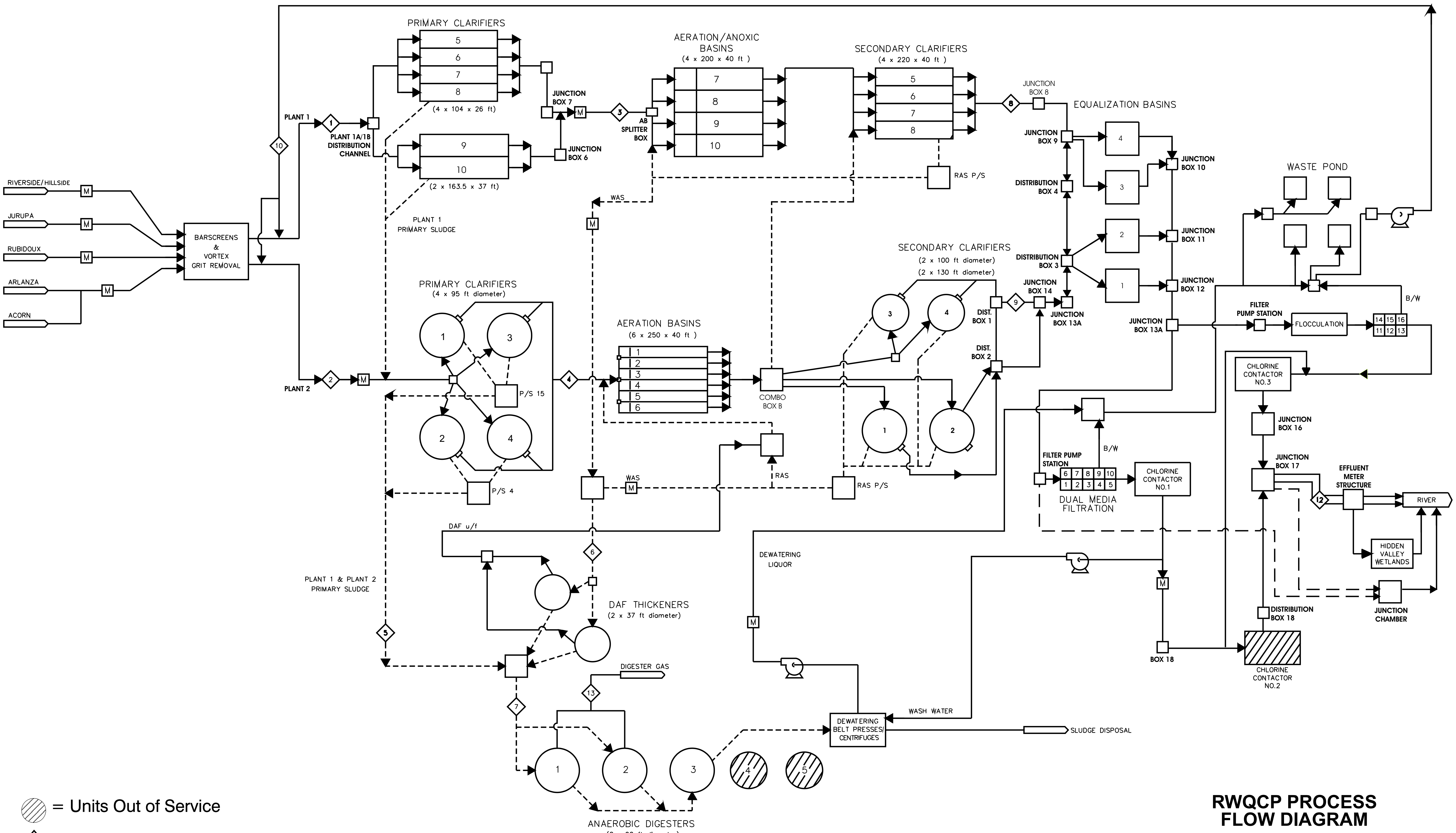
7.3.1 Process Design Criteria

Table 7.1 presents a summary of the design criteria for expansion of facilities at the RWQCP. For detailed information on the process design criteria, refer to Volume 4, Chapter 3 - Process Design and Reliability Criteria.

Table 7.1 Design Criteria for Expansion of the RWQCP
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Effluent Parameter	Value
Design Flows	
Average Dry Weather Flow (ADWF), mgd	52.2
Peak Wet Weather Flow (PWWF), mgd	115[(1)]
Approximate Recycle Flow to Headworks, mgd	5.5
Average Influent Wastewater Characteristics[(2)]	
BOD, mg/L	250
TSS, mg/L	250
TKN, mg/L as N	35.5
Effluent Quality Requirements	
BOD, mg/L	<10
TSS, mg/L	<10
Total Inorganic Nitrogen, mg/L as N	<10[(3)]

Notes:
(1) Based on a wet weather peak hour flow factor of 2.2.
(2) Does not include impact of recycle streams from dewatering, thickening, and tertiary filter backwash.
(3) The current requirement is 13 mg/L, but this will change to 10 mg/L when flows exceed 35-mgd AA.



= Units Out of Service

= Sampling Point No. X

RWQCP PROCESS FLOW DIAGRAM

FIGURE 7.1

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7.3.2 Sludge-Settling Characteristics - *Clariflux*™ Model

There are three different factors that could limit the capacity of a secondary treatment system (aeration basins and clarifiers):

- Aeration Basin Capacity:
  In a nitrifying system, such as at the RWQCP, the basin must be large enough to ensure full nitrification at design loads and minimum expected wastewater temperatures. Basin capacity typically increases as Mixed Liquor Suspended Solids (MLSS) concentration is increased.

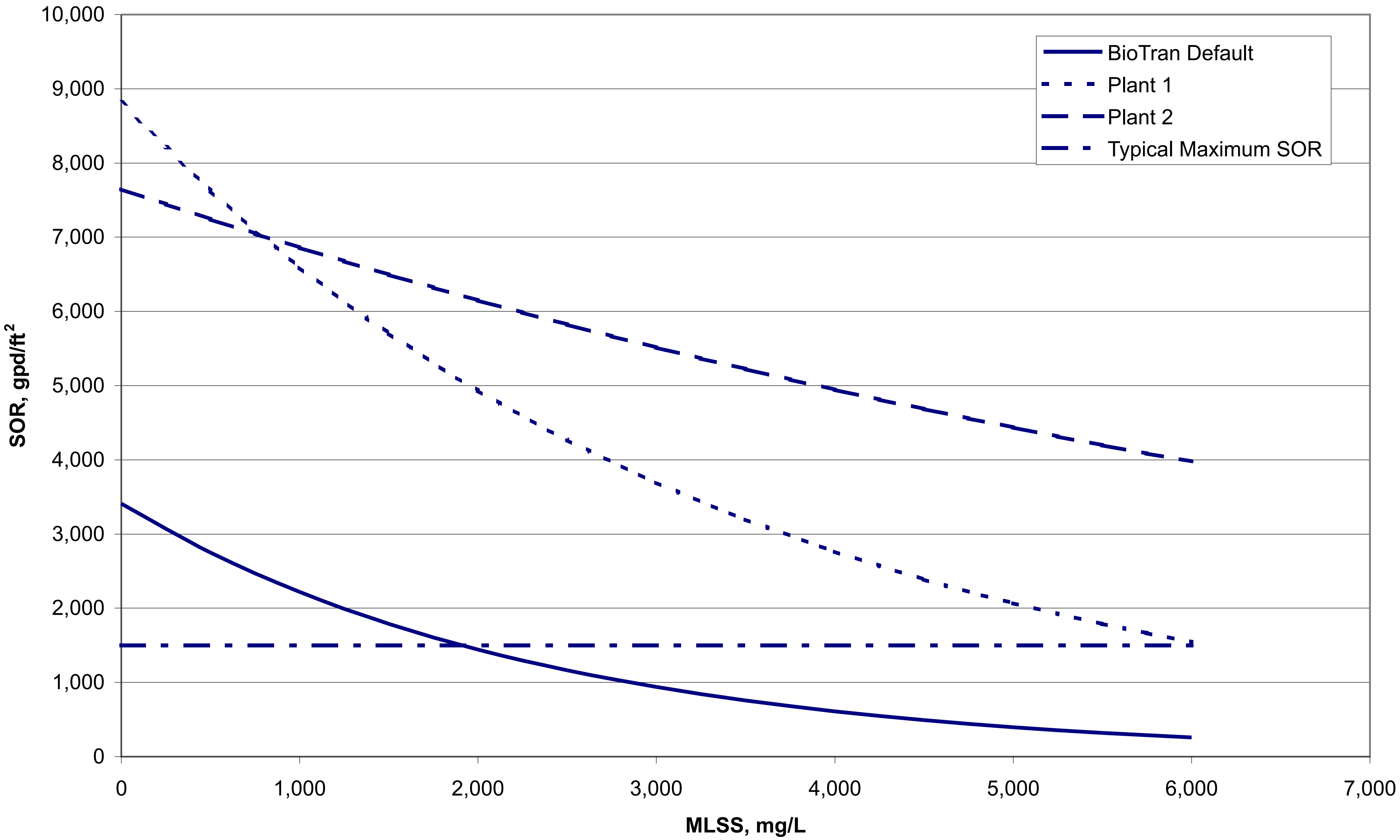
- Aeration System Capacity:
  The aeration system (blowers and diffusers) must be able to supply sufficient oxygen to the aeration basin under design load conditions. Blower capacity must be assessed at maximum expected air temperatures. The oxygen transfer efficiency of the diffusers depends on air flux and process conditions, such as Sludge Retention Time (SRT), MLSS concentration, etc.

- Clarifier Capacity:
  The clarifiers must be able to produce an effluent with a low Total Suspended Solids (TSS) concentration under design loads. Typically, clarifier capacity increases with lower MLSS concentrations.

Both aeration basin capacity and aeration system capacity can be modeled to a high degree of accuracy using existing process models for the aeration system. Secondary clarifier capacity, however, depends on sludge-settling characteristics. These characteristics may be assumed or estimated based on available data such as Sludge Volume Index (SVI) data. Translating SVI data to sludge-settling characteristics does carry some risk, as the SVI test does not discriminate between sludge settling, which determines the required Surface Overflow Rater (SOR) and sludge compaction, which determines the required Return Activated Sludge (RAS) rate.

A sludge-settling test was performed to determine the sludge-settling characteristics of the mixed liquor for both Plants 1 and 2. A sample of mixed liquor from the aeration basin effluent was collected and settling tests were performed, in duplicate, in a 6-foot sludge-settling column. The test was repeated with increasingly dilute mixed liquor samples (diluted with secondary effluent) to obtain initial sludge settling velocity as a function of MLSS concentration. These results were then used to estimate the settling properties of sludge for both Plant 1 and Plant 2.

Rate of settling data for various solids concentrations was collected and compared with typical settling rates. Figure 7.2 shows a summary of the results of the settling tests. The figure shows the effect of MLSS concentrations on the settling rates (i.e., SOR). From the figure, it is apparent that the mixed liquor settles very fast in the secondary clarifiers at both Plants 1 and 2.



SECONDARY SLUDGE SETTLING TEST RESULTS

FIGURE 7.2

The figure suggests that at a typical MLSS operating concentration range of 2,500 to 3,500 mg/L, the clarifiers can be loaded at a much higher SOR ranging from 3,000 to 4,500 gpd/ft^2. This indicates that sludge-settling characteristics are not the limiting factor for the RWQCP secondary clarifiers. Experience and clarifier stress testing at other plants indicate that where SOR exceeds 1,500 gpd/ft^2 hydraulic effects begin to dominate, causing an increase in effluent TSS concentration, regardless of sludge-settling characteristics. Therefore, the loading of the secondary clarifiers should be limited to 1,500 gpd/ft^2 under all conditions.

Hence, in order to increase the capacity at the RWQCP, the clarifiers can be operated at higher SOR, which would enable the operators to maintain a higher MLSS concentration (i.e., higher capacity) in the aeration basins. Table 7.2 summarizes the existing and proposed clarifier operating conditions.

Table 7.2 Summary of Secondary Sludge-Settling Tests
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Plant 1	Plant 2
Current Operation		
Average Influent Flow, mgd	11	20.1
MLSS, mg/L	2,858	3,173
SOR at Average Flow, gpd/ft^2	386	494
Design for 40 mgd		
Average Influent Flow, mgd	20	20
MLSS, mg/L	3,500	2,500
SOR at Average Flow, gpd/ft^2	645	631

Previously during the secondary system upgrades project, done by Carollo Engineers (Carollo) in 2002, the Biotran showed that the plant capacity was approximately 36 mgd. At the time of that project, a settling test was not conducted for the evaluation of the performance of the secondary clarifiers and sludge-settling characteristics were assumed. The settling test results as discussed above indicate that the sludge-settling characteristics at both Plants 1 and 2 are very good, and better than assumed. Due to the good sludge-settling characteristics, the aeration basins can be operated at a higher MLSS to achieve higher treatment capacity. Only the MLSS in Plant 1 can be increased to 3,500 mg/L to increase capacity. The MLSS concentration in Plant 2 should not be increased beyond 2,500 mg/L, as the capacity of Plant 2 is limited by the capacity of the aeration system and not the performance of the secondary clarifiers. Making these adjustments, the combined capacity of the secondary system for Plant 1 and Plant 2 is 40 mgd, based on the Biotran model.

7.4 IDENTIFICATION OF SECONDARY TREATMENT EXPANSION ALTERNATIVES FOR THE RWQCP

Based on the current and expected future treated effluent discharge requirements, and also keeping in mind the City's requirements for future treatment goals and operational flexibility, the following four secondary treatment alternatives were identified:

1. Using EPT to increase secondary treatment capacity.
2. Expand the existing CAS system at Plant 1.
3. Convert the existing Plant 1 secondary treatment facility into a MBR plant capable of treating the 32.2 mgd of plant flow.
4. Convert the existing Plant 1 secondary treatment facility into an IFAS facility.

In addition to the above four processes, the Waste Activated Sludge Anaerobic Contact (WASAC) process was also considered for secondary treatment expansion. The WASAC is a proprietary process developed by Carollo that uses phosphorus-harboring organisms to remove BOD from wastewater in an anaerobic environment. The WASAC process would be inserted between the primary clarifiers and the aeration basins. This process would supplement the secondary treatment process such that the secondary expansion could be delayed. The WASAC process can potentially provide the City significant cost and energy savings. Since at this time the WASAC process has not been proven, it was not evaluated further or recommended to the City. However, in the future, if proven successful through pilot testing, the WASAC process could be a viable alternative for the City, since it could make best use of the existing facilities. Appropriate design considerations were made in this Master Plan to leave room for the potential implementation of the WASAC process.

For this project only the four alternatives listed above were evaluated. The four alternatives are described and discussed in the following subsections.

7.4.1 Enhanced Primary Treatment

EPT doses ferric iron and polymer (typically anionic polymer) to the primary influent to increase flocculation and settling, hence improving primary clarifier performance, specifically TSS and BOD removal. This reduces the load on the secondary treatment plant. The reduced load translates into reduced operating costs (mostly due to lower aeration air requirements and lower secondary solids production). In some cases, the secondary treatment capacity can also be increased. Carollo investigated whether EPT would significantly increase primary clarifier performance by performing a bench test. The effect of EPT on secondary treatment was also considered.

For the test, a sample of primary influent from each plant was taken. The sample was divided into six samples that were dosed with 0.5 mg/L of anionic polymer and different concentrations of ferric chloride: 5, 10, 15, 20, and 25 mg/L. The control received neither ferric nor polymer. All the samples were thoroughly mixed and allowed to settle in Imhoff cones. After about half an hour the settled solids were drained from the Imhoff cone and a sample of the supernatant was collected and submitted to the RWQCP laboratory for analysis. The test results are summarized on Figure 7.3. As shown in the figure, EPT did increase primary clarifier performance. The key results from the experiment are summarized in Table 7.3.

Table 7.3 Enhanced Primary Treatment Bench Test Results
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Plant 1	Plant 2
Control		
COD Removal	32%	24%
TSS Removal	59%	54%
Optimum Dose		
Dose, mg/L as $FeCl_3$	10	15
COD Removal	46%	45%
TSS Removal	68%	71%
Maximum Dose Tested		
COD Removal	50%	49%
TSS Removal	76%	72%

The optimum ferric chloride dose at Plant 1 appeared to be approximately 10 mg/L and 15 mg/L at Plant 2.

The effect of EPT on secondary treatment is summarized in Table 7.4.

Table 7.4 Summary of Enhanced Primary Treatment Testing Results
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Parameter	Conventional	EPT
Aeration Basin Influent		
BOD, mg/L	160	112
TSS, mg/L	101	61
NH_4-N, mg/L	29	28
TKN, mg/L	38	35
Soluble BOD, mg/L	64	60
BOD: TKN Ratio	4.2	3.2
Aeration Basin Operating Conditions		
SRT, days	5.3	8.9
MLSS, mg/L	3,500	3,500
Anoxic Fraction	25%	50%
Primary Sludge, lb/d	63,250	82,900
WAS, lb/d	43,200	25,400
Digester Feed Flow, mgd	0.50	0.49
Aeration Basin Air, scfm	27,600	21,500

Table 7.4 Summary of Enhanced Primary Treatment Testing Results Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside		
Parameter	**Conventional**	**EPT**
Secondary Effluent Quality		
NH_4-N, mg/L	0.7	0.5
Total Organic Nitrogen, mg/L	2.7	2.7
NO_3-N, mg/L	6.9	7.5
Total Inorganic Nitrogen, mg/L	7.6	7.9
Total Nitrogen, mg/L	10.3	10.6

The table confirms that EPT has the potential to reduce the operating costs of the secondary treatment (approximately 22-percent savings in aeration air and 41-percent savings in WAS mass, while primary sludge production increases by 31 percent). However, it should be noted that EPT reduces the BOD to Total Kjeldahl Nitrogen (TKN) ratio in the aeration basin influent from 4.2 to 3.2.

Typically, when this ratio drops below 4.0, special measures are required to achieve a high level of denitrification. In this case, the anoxic fraction in the aeration basin needs to be increased to 50 percent. This means that there is no capacity increase as the reduced aerobic volume requirement with EPT is taken up by the increased anoxic volume. Operating the basin at such a high anoxic fraction may also increase the SVI. Should that happen, secondary clarifier performances would be affected and the secondary treatment capacity could be reduced.

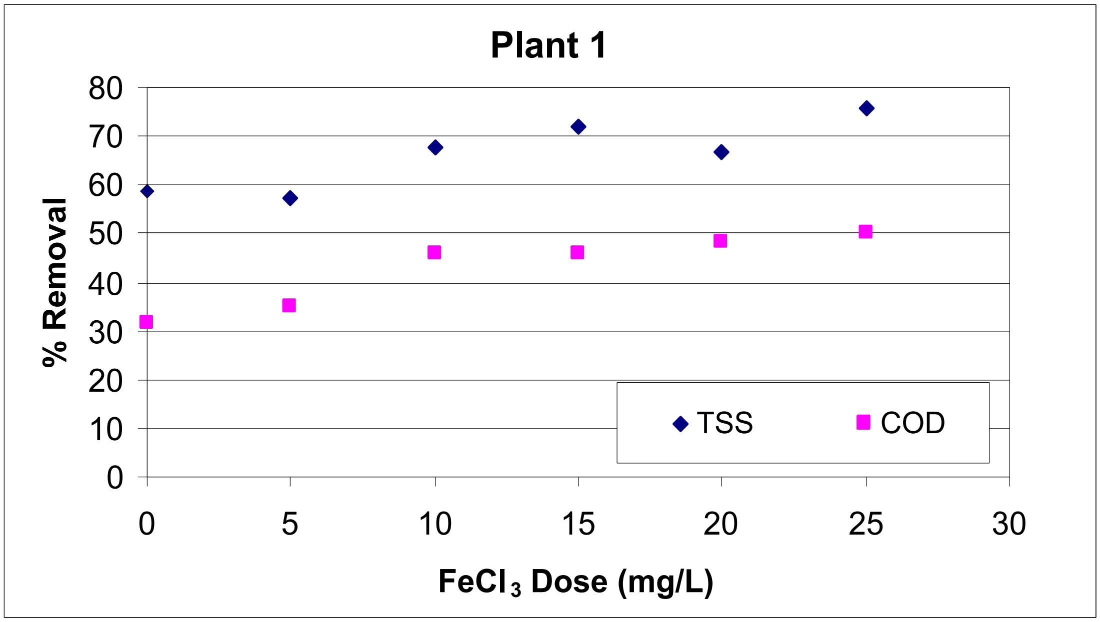
For these reasons, EPT is not recommended for the RWQCP and is not discussed further.

7.4.2 Conventional Activated Sludge Process

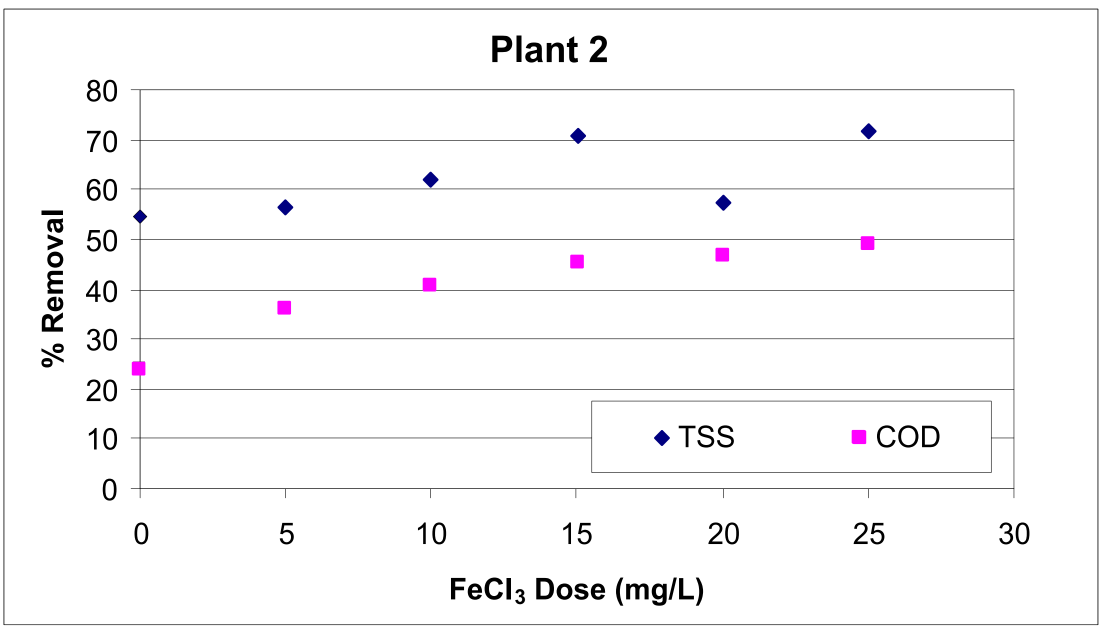
The City operates two separate trains of CAS process. The secondary treatment processes at Plant 1 and Plant 2 are rated at 20-mgd AA each. For future increase in capacity, Plant 1 will be expanded since some of the process units in Plant 1 have aged and there is enough room for future units in Plant 1, whereas Plant 2 has limited room for future expansions. The expansion would increase Plant 1 capacity to 32.2-mgd AA and the total RWQCP treatment capacity to 52.2-mgd AA.

The CAS process is a proven wastewater treatment method and the City has had good experience with the process. Additionally, the operators at the RWQCP are well versed with the operation and maintenance of the facilities involved in a CAS process. Hence, for the next expansion, the CAS process was chosen as a secondary treatment alternative for further evaluation. For the comparison of the treatment alternatives, the CAS alternative was used as a base case scenario. A process schematic of the CAS process is shown on Figure 7.4.

The process requirements for the CAS process are summarized in Section 7.5.



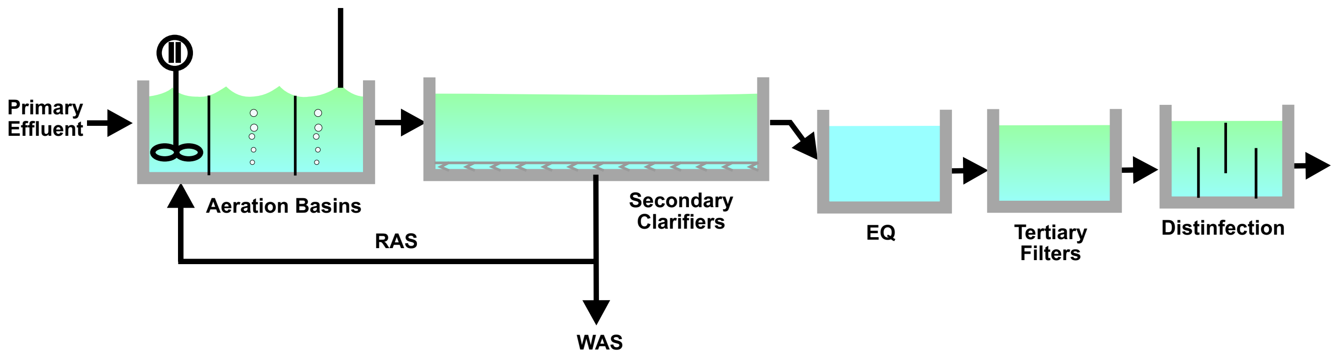
(A)



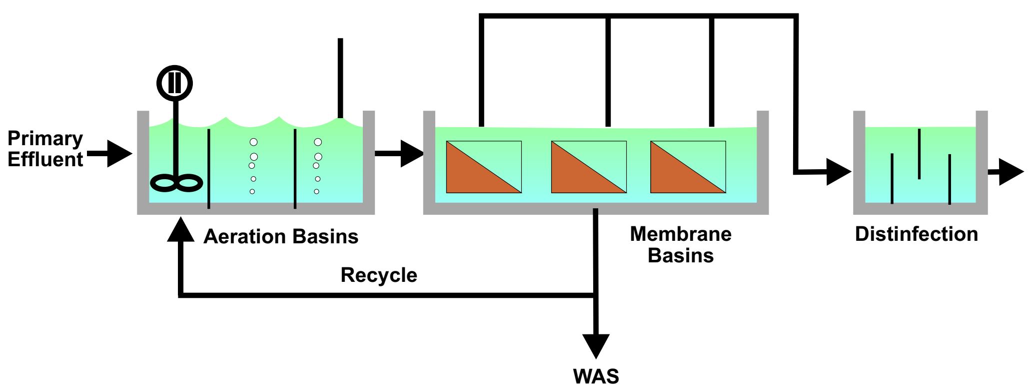
(B)

EPT TEST RESULTS

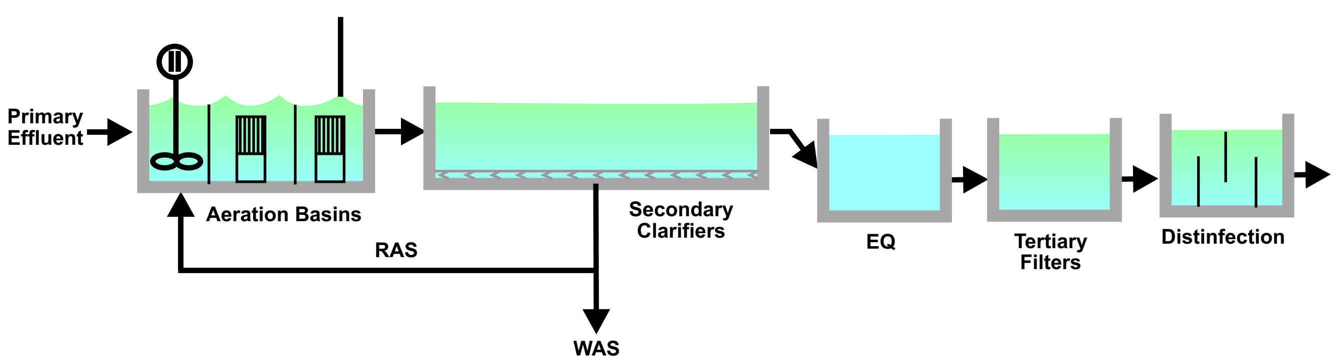
FIGURE 7.3



(A) CAS Schematic



(B) MBR Schematic



(C) IFAS Schematic

PROCESS SCHEMATICS

FIGURE 7.4

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7.4.3 Membrane Bioreactor Process

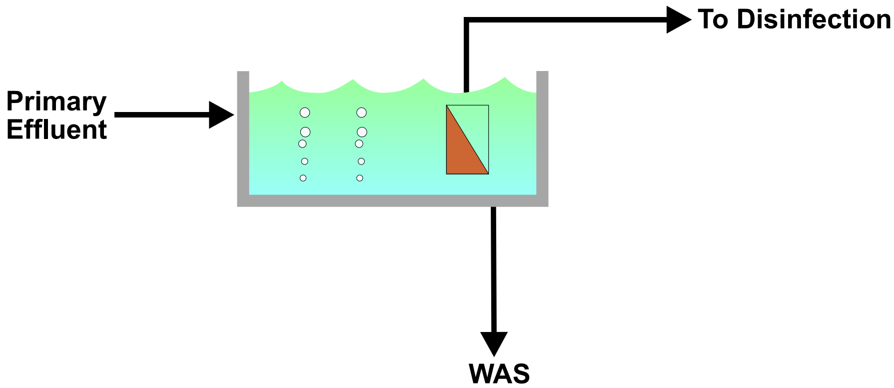
The MBR combines conventional biological treatment with the use of membranes for the separation of the solid and liquid phases. The MBR treatment train is similar to the existing secondary processes except that membranes replace the secondary clarifiers and tertiary filters. In the MBR process, the MLSS can be increased beyond that which is possible in CAS systems. Figure 7.4 includes a process schematic for the MBR alternative.

Typically, MBR systems operate at MLSS concentrations in the range of 8,000 to 10,000 mg/L, compared with a value of around 2,500 to 3,000 mg/L in the CAS. The higher MLSS provides the benefit of a greater treatment capacity per unit volume of aeration basin. In order to minimize the solids buildup near the membrane surface, which would reduce the flow of water through the membranes, membrane agitation air is introduced to scour the membrane surface. This air is usually in addition to the biological process air requirements, although at least one manufacturer combines both air needs as shown on Figure 7.5, part (A).

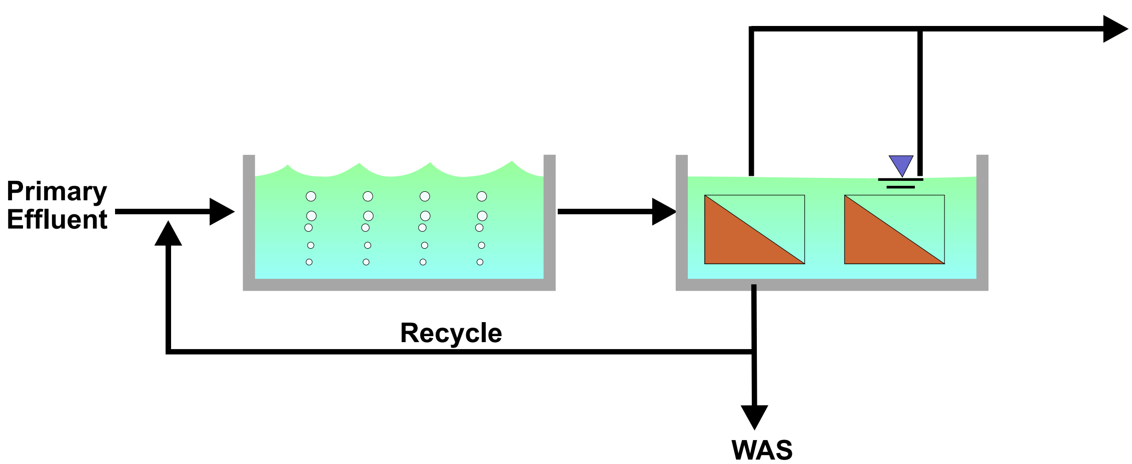
Because the process incorporates a membrane barrier, it produces a low turbidity effluent that is not impacted by quality changes in the feed water. Another benefit is that the effluent TSS concentration is low enough that tertiary filtration is not required. In addition, the treated effluent consistently has a low turbidity, which means process reliability is good. Finally, because the MBR system would operate at a longer SRT, there would be some endogenous destruction of the biomass within the process. Therefore, total sludge production from the facility be would reduced by about 10 to 15 percent, compared with operating a CAS plant.

The higher SRT also has benefits related to future regulatory requirements. At the Inland Empire Utilities Agency Regional Plant 5, it was shown that operating a CAS at a very high SRT (40 days) the effluent was able to perform much better in the WET test. Operating at a high SRT also improves the destruction of recalcitrant compounds including EDCs. The consistently low TSS concentration in the MBR effluent also means that disinfection is easier to achieve and that more disinfection process options are available. The MBR effluent would also be most compatible with using an advanced oxidation process (such as ozone) to destroy remaining organic compounds. All these factors make MBR the process that could most easily be combined with advanced tertiary treatment options to meet future effluent limits (Volume 2, Chapter 2 - Regulatory Requirements).

All MBR systems require screening of the influent to protect the membranes. In systems that incorporate hollow-fiber membranes (most systems), it is important that abrasive solids and hair be removed. To accomplish this, MBR systems require fine screening of the feed water in the range of 1 mm. Abrasive solids can wear through the membrane fibers and cause failures, while hair wraps around the fibers, causes clumping of the mixed liquor and is very difficult to remove. Ideally, fine screens are installed upstream of the aeration basins, but they can also be installed in the sludge recycle line between the aeration basins and the membrane tanks depending on the site layout.



(A) Combined Membrane-Aeration Tank



(B) Separate Membrane Tank

MBR PROCESS CONFIGURATION

FIGURE 7.5

One MBR supplier has a flat sheet membrane configuration, which is less susceptible to issues with hair, but is still subject to abrasion. This system can be used with 3-mm screens.

Even with air agitation, membranes lose their water permeability (flux rate) with time and require cleaning. Most MBR systems include regular relaxing (zero flux) or back pulsing (using permeate to dislodge accumulated solids). Depending on operating conditions, a chemical clean may be required every 3 to 6 months. Chemical cleaning typically involves submerging the membranes in a solution of either sodium hypochlorite (to remove biological fouling) or citric acid (to remove lime scale).

There are different ways to configure an MBR system as shown on Figure 7.5. In the original plants that were built (around 1 mgd or less), the membranes (in the form of cassettes) were simply installed directly into the aeration basins creating a combined membrane-aeration tank. When it is time for chemical cleaning, the membrane cassettes are lifted out of the aeration basins (by crane) and dipped into a cleaning tank. Cleaning could require 4 to 6 hours of soaking before the cassette is returned to the aeration basin. Alternatively, at least one manufacturer operates by cleaning the membranes in place in the aeration basin.

The other approach to designing MBR systems, as shown on Figure 7.5, part (B), is to construct a separate membrane tank to house the membranes. The mixed liquor is circulated from the aeration basin to the membrane tank and back to the aeration basin. In this configuration, the membrane tank can be divided into cells that can be taken off-line and cleaned. A potential disadvantage of this approach is that a separate tank is required. For the RWQCB, the secondary clarifiers could be modified to become the membrane tanks.

A comparison of the separate membrane tank approaches is presented in Table 7.5.

Table 7.5 Comparison of Combined and Separate Membrane Tank Processes
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Combined Membrane-Aeration	Separate Membrane Tank
Removing membranes, placing them in a small cleaning tank and then returning them to the aeration basins is operator intensive.	Removal of membrane cassettes for cleaning is not needed, as individual cells can be taken off-line.
Without individual flow control on each cassette, the clean membrane, when returned to operation, would take most of the load compared to the other membrane cassettes. This leads to uneven distribution of flow through the membrane cassettes and inefficient use of the available membrane area.	A complete train of membranes can be cleaned simultaneously, so the flow through the membranes can be controlled (relative to the other trains) when the clean membranes are brought back online. Major modifications to the aeration basins are not required.

Table 7.5 Comparison of Combined and Separate Membrane Tank Processes
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Combined Membrane-Aeration	Separate Membrane Tank
Aeration basins tend to be much deeper than required to house the membranes, so complex systems are required to support the membranes and associated piping.	The activated sludge biological system can be designed, configured, and operated independently of the membrane tanks.
	The separate membrane tank approach is well suited to larger installations where the number of membrane cassettes is high.

The main disadvantage of the separate membrane tank configuration is that a high rate mixed liquor recycle system must be installed and operated. Typically, a recycle rate of 400 percent is used to maintain the aeration tank MLSS concentration at 80 percent of the membrane tank MLSS concentration.

Based on the above discussion, the combined membrane-aeration tank option is not considered further. For the preliminary evaluation of expansion of Plant 1, the separate membrane tank approach will be used.

The process requirements for converting the Plant 1 CAS system to an MBR system are summarized in Section 7.5.

7.4.4 Attached Growth Processes

Attached growth processes use biomass attached to media to perform the required biological transformations. In these applications, the attached growth forms a film on the media; this is referred to as biofilm. The differences between suspended and attached growth processes are summarized in Table 7.6.

Table 7.6 Comparison of Suspended and Attached Growth Processes
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Suspended Growth	Attached Growth
No gradient for soluble compounds under typical conditions.	A significant gradient that drives diffusion of soluble compounds.
Biomass moves with effluent through bioreactor.	Biomass stationary while effluent passes through.
Bioreactor effluent has a high TSS concentration.	Bioreactor effluent TSS is low.
Clarifier design must take both solids and hydraulic loads into account.	Clarifier design based on hydraulic loading only.
Produces more WAS.	Produces less WAS.
Process parameters (such as SRT, aeration MLSS concentration) can be controlled.	Limited process control options.

Table 7.6	Comparison of Suspended and Attached Growth Processes Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside
Suspended Growth	**Attached Growth**
Provides contact time between biomass and effluent of several hours.	Contact time of minutes.
Can be designed to perform Biological Nutrient Removal (BNR).	Limited ability to perform BNR.
Superior effluent quality.	Inferior effluent quality.

Some modern attached growth processes differ from the more traditional processes in that in the modern process the media is submerged below the water surface. This means that, as for suspended growth processes, aeration air must be introduced at pressure (related to the diffuser submergence depth). This also allows for increased contact times, but still does not allow the operator to completely control the solids inventory.

There are two versions of the modern attached growth processes:

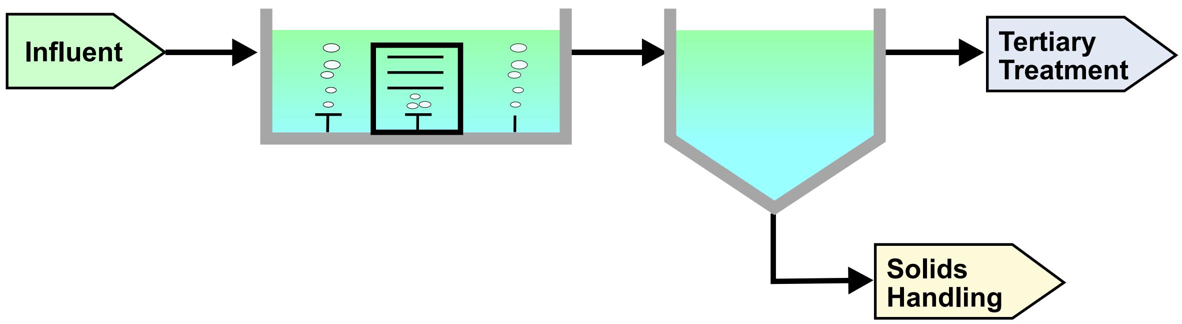
- Moving Bed Bioreactor (MBBR) or Submerged Fixed Film (SFF).
- IFAS.

The process schematic for each process is shown on Figure 7.6. Primary effluent enters the basin that contains the media and the attached biomass. The effluent from the basin passes through a clarifier before proceeding to tertiary treatment. Settled sludge goes to sludge handling. For MBBR/SFF, as with trickling filter effluent, the TSS concentration in the bioreactor effluent is low.

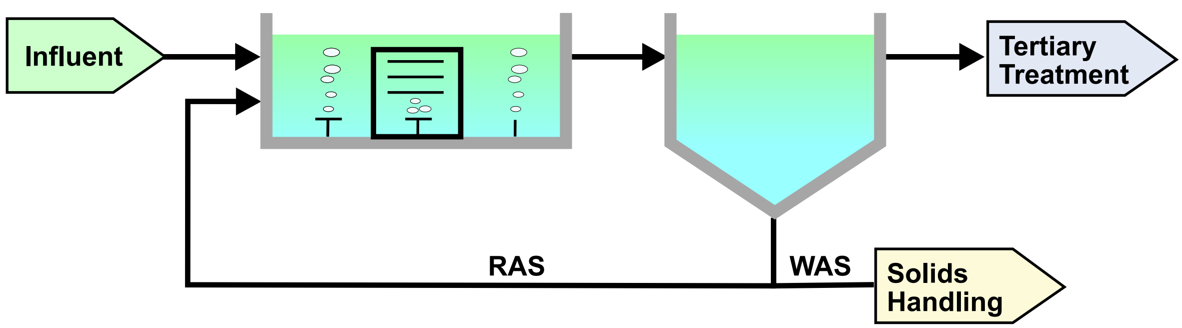
The IFAS process schematic is similar to the MBBR/SFF flow diagram. The main difference is the presence of a RAS line that allows the cultivation of suspended biomass in addition to the attached biomass. The bioreactor effluent has a high TSS concentration, similar to suspended growth processes.

The two processes are compared in Table 7.7.

Table 7.7	Comparison of IFAS and MBBR Processes Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside
MBBR/SFF	**IFAS**
Attached biomass only	Attached and suspended biomass
No RAS line	RAS to a CAS process
Biomass inventory cannot be controlled	Biomass inventory can be partially controlled
Pin floc due to low TSS in basin effluent	Typically have low SVI
No control over solids inventory	Solids inventory can be controlled



MBBR/SFF



IFAS

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ATTACHED GROWTH PROCESS SCHEMATIC

FIGURE 7.6

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WASTEWATER COLLECTION AND TREATMENT FACILITIES INTEGRATED MASTER PLAN

CITY OF RIVERSIDE

The IFAS system has some important advantages, especially the ability to partially control biomass inventory (or SRT). Since the activated sludge process at the RWQCP already includes RAS pumps and provisions to handle high bioreactor TSS concentrations, there is no additional investment for selecting IFAS above MBBR. In addition, the suspended biomass does not have to be attached to media, which means that the total surface area of the required media is reduced. For these reasons, further evaluation of attached growth processes is based on an IFAS system.

There are two different kinds of media that can be used with the IFAS system, free floating or fixed, as shown on Figure 7.7. The free-floating media consist of small plastic elements that have positive buoyancy. Fixed media is typically attached to a frame that can be lowered to the floor of the basin. Fixed media can consist of either rigid media (like structured packing used in trickling filters) or pliable media (typically attached to a frame that allows for limited media movement). Free-floating and fixed media are compared in Table 7.8.

Table 7.8 Comparison of Fixed Film Process Media
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

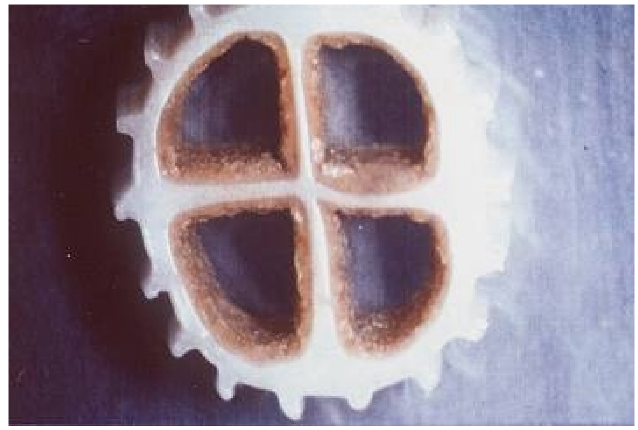
Free-Floating Media	Fixed Media
Influent: Fine Screens and Primary Treatment are required	Influent: Fine Screens not required
Coarse Bubble Aeration only	Fine or Coarse Bubble Aeration
Screens required in Basin to Retain Media[1]	No Screens required in basin
Large area per unit volume	Smaller area per unit volume

Notes:
(1) Screens typically produce 2 to 6 inches of water column head loss, per screen.

Free-floating media require fine screens upstream of the basin to prevent plugging of the screens in the basin itself. Coarse bubble aeration is required to achieve enough turbulence to ensure a good distribution of the media throughout the basin depth. The coarse air also helps to prevent plugging of the basin's screens. The free-floating media allows greater treatment capacity for a given basin volume, due to its greater surface area.

Due to the facts that the City has recently installed new fine bubble diffusers and that plant hydraulics are already a limiting factor, it was decided to concentrate on fixed media for this evaluation. The evaluation specifically considered pliable media, as it allows more biomass attachment per unit area. Should IFAS be selected, a comparison of rigid and pliable media alternatives can be made during preliminary design.

To increase the treatment capacity at the RWQCP to 52.2 mgd, both Plant 1 and Plant 2 CAS processes would have to be converted to the IFAS process. The process requirements for the conversion are summarized in Section 7.5.



Free Floating Media

Rigid Media

Pliable Media

Fixed Media

ATTACHED GROWTH MEDIA OPTIONS

FIGURE 7.7

7.5 PROCESS MODELING OF TREATMENT ALTERNATIVES

7.5.1 Conventional Activated Sludge Alternative

Expansion using CAS would entail adding aeration basins and secondary clarifiers to the Plant 1 system. The primary effluent piping from the new Plant 1 primary clarifiers would need to be expanded. Mixed liquor piping between the Plant 1 aeration basins and secondary clarifiers would also need to be expanded. Secondary effluent piping to transfer secondary effluent to the equalization basins would also need to be expanded. The diffuser count in the existing basins would be increased from the current 588 to 694 units.

7.5.2 Membrane Bioreactor Alternative

One additional aeration basin would be required. The recycle from the membrane tank will have a high Dissolved Oxygen (DO) concentration and would inhibit denitrification if returned to the anoxic zone of the aeration basins. Instead, the membrane tank recycle will be discharged in the aerobic zone of the aeration basin. The existing mixed liquor return system in the aeration basins would be expanded from the existing 7,000 gpm to 17,000 gpm. The diffuser count in the existing basins would be increased to 1,096 units. Two of the existing secondary clarifiers would be retrofitted into membrane tanks. There would be nine trains in total. The plant would be able to operate at full capacity even with one membrane train out of service.

The MBR system in Plant 1 would treat 32.2 mgd, to give a total capacity of 52.2 mgd for the whole plant. Treated effluent would be pumped through the membrane by permeate pumps and the solids would be returned to the aeration basin by recycle pumps. WAS would be withdrawn from the return line where the MLSS concentration is at its highest.

In order to implement this alternative, fine screens (about 1-mm openings) would need to be installed. Based on the existing site configuration it is proposed that the screens would be installed to treat the primary effluent upstream of the Plant 1 aeration basins. A new pipe would be needed to convey primary effluent from the new Plant 1 primary clarifiers (Volume 4, Chapter 6 - Primary Treatment). In addition, the Plant 1 aeration basin influent channel would need to be extended for the new aeration basin. By further extending this channel, a channel is created that could house the new fine screens. However, due to the high head loss at the fine screens, there might be a need to pump the primary effluent to accommodate the screens. The hydraulic requirements should be determined during the preliminary design.

7.5.3 Integrated Fixed Film Activated Sludge Alternative

Implementing the IFAS process would mean increasing the secondary treatment capacity of both Plants 1 and 2. It is estimated that a total media surface area of 1,360,000 $feet^2$ would need to be installed in Plant 1 and 1,836,000 $feet^2$ in Plant 2. The increased biomass in the aeration basins would increase the oxygen demand, increasing required blower capacity as well as diffusers. The diffuser count in Plant 1 would increase to 896 units per basin and to 818 units per basin in Plant 2.

7.5.4 Process Modeling

A Biotran process model was set up for the three secondary treatment alternatives for the RWQCP. A copy of the Biotran model is included in Appendix A. The modeled plant performance characteristics are summarized in Table 7.9. Figures 7.8, 7.9, and 7.10 show the proposed layout for the CAS, MBR, and IFAS alternatives, respectively.

Table 7.9 Modeling of Secondary Treatment Alternatives for Plant 1
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

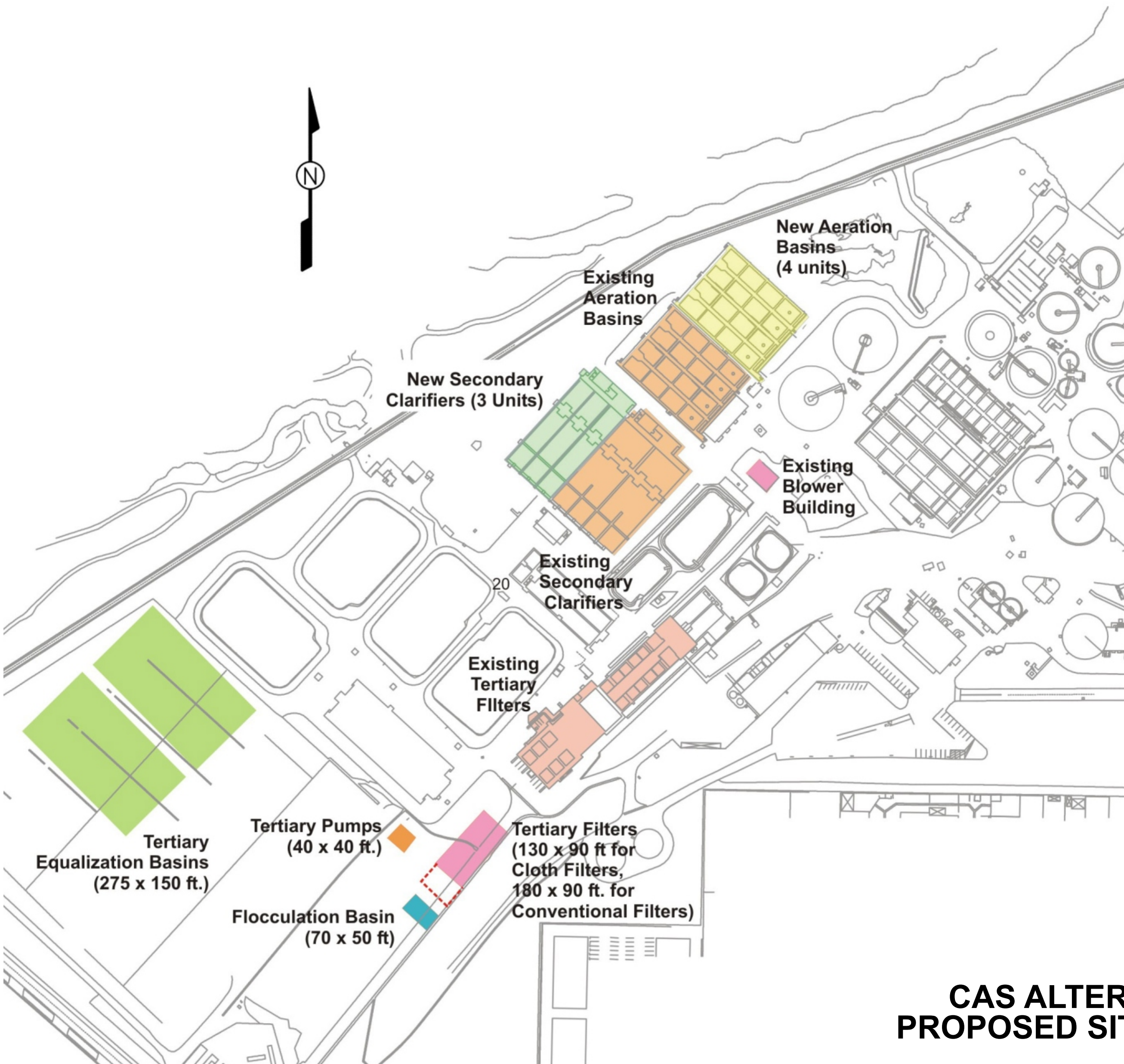
Parameter	CAS	MBR	IFAS Plant 1(1)	IFAS Plant 2(1)
Aeration Basin Influent(2)				
Average Flow, mgd	32.2	32.2	22.1	30.1
BOD, mg/L	160	169	164	176
TSS, mg/L	101	106	104	130
VSS, %	86	90	88	109
NH_3-N, mg/L	29.2	32.5	27.8	30.3
Organic-N, mg/L	8.7	8.9	8.8	9.8
NO_3-N, mg/L	0.6	0.3	0.4	0.7
Alkalinity, mg/L as $CaCO_3$	266	279	262	270
Filterable ("soluble") BOD, mg/L	64	67	66	63
Process Requirements				
No. of Fine Screens	N/A	4	N/A	N/A
Clear Screen Opening, mm	N/A	~1	N/A	N/A
New Aeration Basins	4	1	0	0
New Secondary Clarifiers	3	0	0	0
Membrane Tanks	N/A	2(3)	N/A	N/A
Tertiary Equalization Requirement	Yes	No	Yes	Yes
New Tertiary Filters(4)	10	0	10	10
Aeration Basin Operating Conditions				
SRT, days	5.3	9.6	6.5	5.6
MLSS, mg/L	3,500	10,000	5,500(5)	4,500(5)

Table 7.9 Modeling of Secondary Treatment Alternatives for Plant 1 Wastewater Collection and Treatment Facilities Integrated Master Plan City of Riverside				
Parameter	**CAS**	**MBR**	**IFAS Plant 1**(1)	**IFAS Plant 2**(1)
WAS, lb/day	43,200	40,500	28,000	55,150
Aeration Basin Air, scfm	29,500	35,200	22,400	32,300
Scour Air, scfm	N/A	25,000(6)	N/A	N/A
Sludge Disposal, wet tons/day	206	198	207	
Expected Secondary Effluent Quality				
BOD, mg/L	3	1	3	3
TSS (nominal), mg/L	5	0	5	5
Ammonia, mg/L as N	0.7	0.3	0.5	0.5
Total Organic Nitrogen, mg/L as N	2.7	2.3	2.6	2.6
NO_3-N, mg/L as N	6.9	7.3	5.4	5.4
Total Inorganic Nitrogen, mg/L	7.6	7.6	5.9	5.9
Total Nitrogen, mg/L	10.3	9.9	8.5	8.5
Turbidity, NTU	<1.0	<0.2	<1.0	<1.0

Notes:

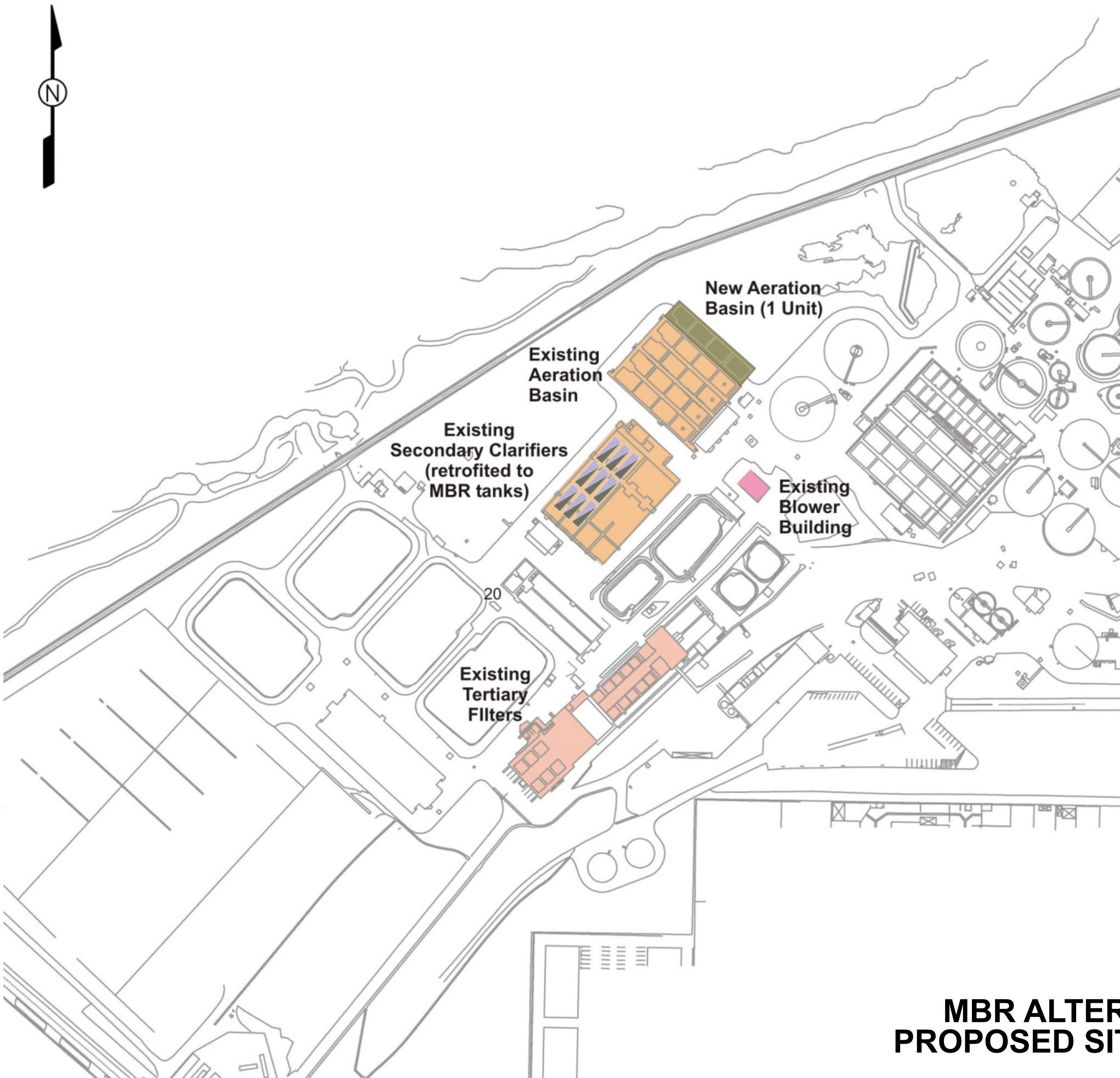
(1) For the IFAS alternative, it is assumed that both Plants 1 and 2 would be converted to IFAS from CAS.
(2) The aeration basin influent quality varies for the three processes because of the effects of the different quality of the recycle streams.
(3) Two Plant 1 secondary clarifiers would be retrofitted into membrane tanks.
(4) For this analysis, it is assumed that if the City decides to expand the tertiary filtration facility, the new filter would be a cloth-media filter (for details refer to Volume 4, Chapter 8 - Tertiary Treatment).
(5) The MLSS concentrations for the IFAS systems are effective biomass concentration values (including attached growth) and not the actual MLSS concentration.
(6) The scour air is required only for 15 seconds per minute during normal operation. Under high loads, the scour aeration rate can be doubled to 30 seconds per minute.

MBR effluent quality is better than the other alternatives, particularly for TSS and turbidity. Tertiary filtration is not required for this alternative. In the future, if the City has to use Reverse Osmosis (RO) treatment to meet lower dissolved salt limits or is required to have higher quality recycle water, the MBR alternative provides a distinct advantage.



CAS ALTERNATIVE PROPOSED SITE LAYOUT

FIGURE 7.8



MBR ALTERNATIVE PROPOSED SITE LAYOUT

FIGURE 7.9

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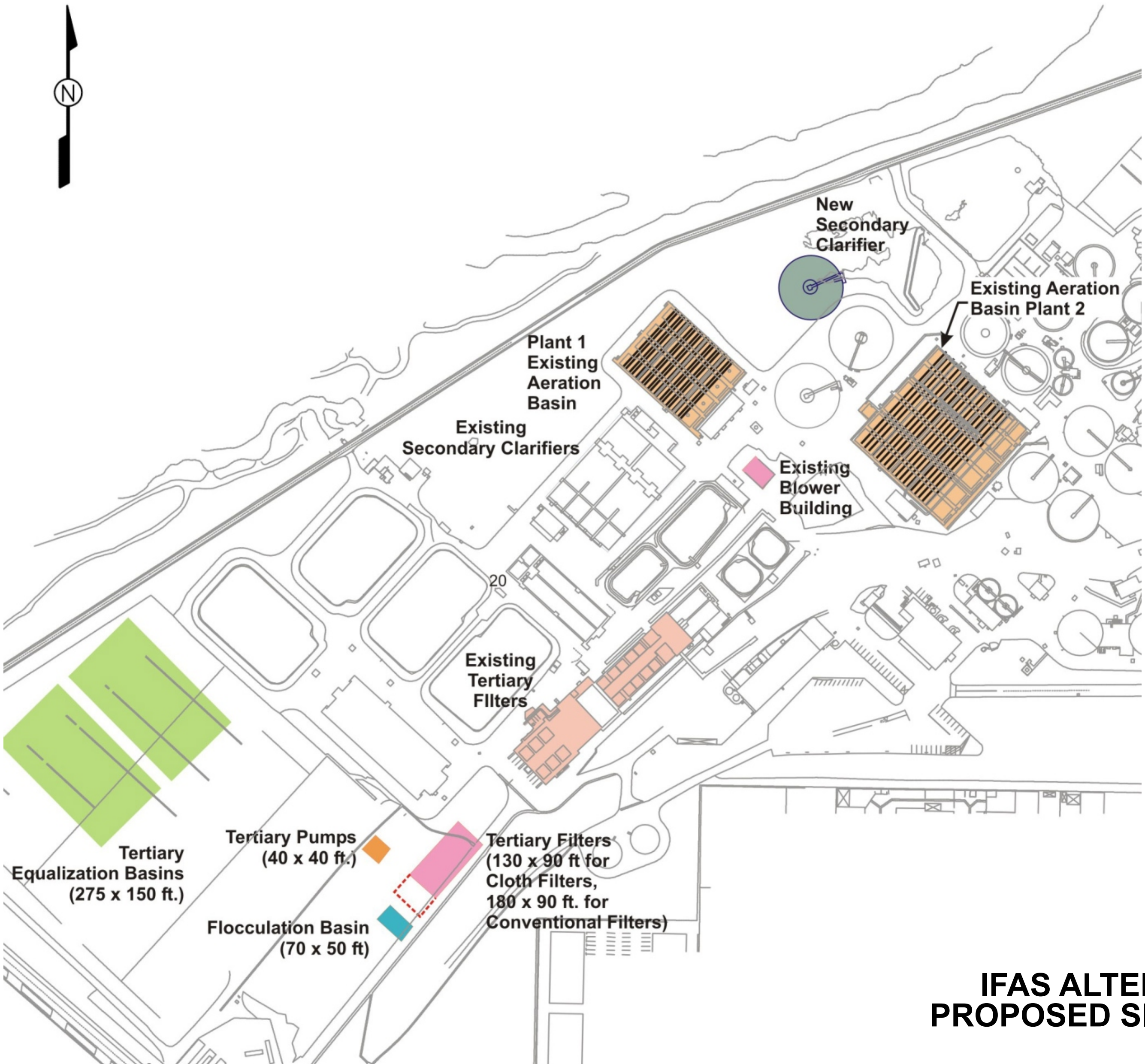

IFAS ALTERNATIVE PROPOSED SITE LAYOUT

FIGURE 7.10

7.6 COMPARISON OF SECONDARY TREATMENT ALTERNATIVES

7.6.1 Non-Economic Comparison

Table 7.10 lists some advantages and disadvantages for the three alternatives discussed above.

Table 7.10 Advantages and Disadvantages of Secondary Treatment Alternatives
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

Advantages	Disadvantages
Alternative 1 - CAS	
• Proven system with long operational history. • Relatively easy to control and operate.	• Large volume and footprint requirements. • Limited to MLSS concentrations in the 1,000- to 5,000-mg/L (max.) range.
Alternative 2 - MBR	
• Longer SRTs increase the potential for complete nitrification. • Longer SRTs enhance the oxidation of recalcitrant toxic compounds, which may be regulated in the future. • Stable process operation due to higher MLSS. • Longer SRTs lead to lower sludge production. • High-quality effluent irrespective of fluctuation of influent water quality. No tertiary filtration required. • Small footprint.	• High MLSS and SRT means higher aeration cost. • High operating costs due to scour air requirement. • High membrane replacement costs. • Most membrane units available in the market are proprietary and the units are not interchangeable.
Alternative 3 - IFAS	
• Higher effective MLSS translates to higher aeration basin capacity. • Improved sludge settleability increases capacity of secondary clarifiers. • Small footprint.	• New technology with limited operational history. • Treatment performance deteriorates at peak flow conditions. • Most existing installations are small plants with limited operational/performance data. • Media for attached growth is proprietary. • Process models are still under development.

Table 7.11 summarizes a comparison of the three different secondary stream treatment alternatives discussed above.

Table 7.11 Comparison of Recycle Treatment Alternatives
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	CAS	MBR	IFAS
Toxics Removal	0	+	0
EDCs Removal	0	+	0
Sludge Settleability	0	0	+
Sludge Thickenability	+	0	+
Tertiary Filters Required	YES	NO	YES
Disinfectability	0	+	0
Reliability	0	+	0
Constructability	–	0	0
Maintenance Requirements	0	–	+
Energy Input	+	–	+
Operating Experience	+	0	–
Process Complexity	0	–	0
Recovery from Upset	–	0	+

Legend:
\+ = Positive comparative characteristic.
– = Negative comparative characteristic.
0 = Neutral comparative characteristic.

7.6.2 Economic Evaluation

A life-cycle cost analysis was performed for the three process alternatives. Costs were estimated for the following three different conditions:

1. Treatment train with primary effluent equalization.
2. Treatment train without primary effluent equalization but with secondary effluent equalization.
3. Secondary treatment with high SRT.

A summary of the costs for the treatment train alternative with primary equalization is shown in Table 7.12.

Table 7.12 Life-Cycle Cost of Secondary Treatment Alternatives - With Primary Effluent Equalization
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	CAS	MBR	IFAS
Project Cost	$103,105,000	$118,190,000	$104,970,000
Annual O&M Cost	$1,150,000	$1,800,000	$1,120,000
Membrane/Media Replacement Cost(1)	N/A	$6,610,000(2)	$700,000(3)
Life-Cycle Cost(4)	**$122,890,000**	**$158,800,000**	**$135,500,000**

Notes:
(1) The costs associated with replacement of diffusers and other process equipment was not included for this comparison as the costs for such items would be similar for all three alternatives.
(2) For this analysis, it was assumed that the average membrane life is 6 years. The replacement cost includes only the cost for replacing the membranes.
(3) The cost of media replacement was based on the assumption that about 5 percent of the media would be destroyed or lost every year.
(4) As present value, assuming life-cycle period of 19 years, discount rate of 6 percent, and escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

The table shows that CAS is the most cost effective, with IFAS the next most cost effective. To show the effect of primary effluent equalization the cost estimates for all three options without primary effluent equalization are summarized in Table 7.13.

Table 7.13 Life-Cycle Cost of Secondary Treatment Alternatives - Without Primary Effluent Equalization
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	CAS	MBR	IFAS
Project Cost	$95,824,000	$126,992,000	$98,370,000
Annual O&M Cost	$1,152,000	$1,624,000	$1,120,000
Membrane/Media Replacement Cost(1)	N/A	$ 6,600,000(2)	$700,000(3)
Life-Cycle Cost(4)	**$115,610,000**	**$166,740,000**	**$128,880,000**

Notes:
(1) The costs associated with replacement of diffusers and other process equipment was not included for this comparison as the costs for such items would be similar for all three alternatives.
(2) For this analysis, it was assumed that the average membrane life is 6 years. The replacement cost includes only the cost for replacing the membranes.
(3) The cost of media replacement was based on the assumption that about 5 percent of the media would be destroyed or lost every year.
(4) As present value, assuming life-cycle period of 19 years, discount rate of 6 percent, and escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

A comparison of these two tables shows that without primary effluent equalization there is an even bigger difference between MBR and the other two options. This is due to the fact that without equalization, more membrane cassettes must be installed to allow the system to handle the higher diurnal peaks. Hence, the primary effluent equalization benefits the economics of the MBR alternative. However, the costs presented above do not account for the benefits of an MBR system regarding WET. Drury et al. (1999) postulated that both high SRT and high MLSS concentration were helpful in improving effluent WET results. High SRT would enable slow growing biomass, capable of toxic compound destruction, to survive in the aeration basin. High MLSS concentrations would improve adsorption of the toxic compounds onto the biomass. As indicated in Table 7.9, the MBR alternative would have both higher SRT and MLSS concentration than the other two alternatives. The high MLSS concentration is unique to the MBR process. This means that if the Drury hypothesis is correct, the MBR process will have unique advantages regarding WET. It is assumed that EDCs would respond the same way as toxic compounds to an increase in both MLSS concentration and SRT. If the CAS and IFAS systems were to be designed for a higher SRT, the process would require additional aeration basins and secondary clarifiers. Table 7.14 shows a cost estimate that assumes operating all three processes at a high SRT.

Table 7.14 Life-Cycle Cost of Secondary Treatment Alternatives - High SRT (Without Primary Effluent Equalization)
Wastewater Collection and Treatment Facilities Integrated Master Plan
City of Riverside

	CAS	**MBR**	**IFAS**
Project Cost	$139,730,000	$126,922,000	$137,720,000
Annual O&M Cost	$1,095,000	$1,624,000	$1,053,000
Membrane/Media Replacement Cost(1)	N/A	$6,600,000(2)	$700,000(3)
Life-Cycle Cost(4)	**$159,082,000**	**$166,740,000**	**$167,120,000**

Notes:
(1) The costs associated with replacement of diffusers and other process equipment was not included for this comparison as the costs for such items would be similar for all three alternatives.
(2) For this analysis, it was assumed that the average membrane life is 6 years. The replacement cost includes only the cost for replacing the membranes.
(3) The cost of media replacement was based on the assumption that about 5 percent of the media would be destroyed or lost every year.
(4) As present value, assuming life-cycle period of 19 years, discount rate of 6 percent, and escalation rate of 6 percent for the first 5 years and 4 percent thereafter.

The table shows that increasing the SRT for the CAS and IFAS systems increases the capital cost for the alternative to more that that of the MBR system. The annual operating and maintenance cost is still higher for the MBR alternative. The result is that the life-cycle cost for all three alternatives are with the range of uncertainty for the cost estimates. Under these conditions life-cycle costs do not strongly favor any of the three options. Based on the ability to achieve better effluent quality and do so more consistently, the City chose the MBR alternative for future expansion.

7.7 EXPANSION PROJECT PHASING

Current flows of approximately 33 mgd (80 percent of rated capacity) and 30-day running averages as high as 35 mgd would indicate that the RWQCP needs additional capacity. The City has no control over how fast the CSDs and the Highgrove area increase their flows into the RWQCP. And, based on housing activity in the summer of 2006, there was concern that residential development would grow faster than was currently predicted. If these occurred there was a good chance that RWQCP flows would tend toward the high-growth scenario. In addition, for a master planning process it is more prudent to plan based on conservative assumptions about future growth. For these reasons, the City chose to use the high-growth scenario (52.2 mgd and an annual growth rate of 1.5 percent) as the basis of the process alternative evaluations for the Integrated Master Plan. This decision was made at a meeting on August 31, 2006. Since that time, a slow down in the housing market has occurred, which caused the City to reevaluate the potential RWQCP influent flows for the master plan planning period. Based on the reevaluation, the City, at a meeting on September 20, 2007, decided that the lower end of the 90-percent confidence interval would be more appropriate as the basis for 2025 RWQCP flow projections. This results in an average daily flow of 47.3 mgd, which corresponds to an annual growth rate of 0.75 percent (low-growth scenario). The City therefore decided to expand the secondary treatment facilities in two phases. The first phase will expand the treatment capacity of Plant 1 from 20 mgd to 26.1 mgd and the second phase to 32.2 mgd. The capacity of Plant 2 will remain at 20 mgd.

For such a phased expansion, the City has decided to purchase MBR equipment to construct an MBR facility of 26.1 mgd. However, the Plant 1 structures will be modified to handle the final expanded flow capacity of 32.2 mgd during the first phase and the additional aeration basin would be constructed. The MBR equipment for the full capacity will be procured when actual influent flow to the RWQCP starts approaching the 46.1-mgd capacity of the first phase.

7.8 CONTROL OF EFFLUENT ORGANICS

The City presently owns and operates constructed wetlands in the Hidden Valley area. Originally developed to aid in nutrient removal, such wetlands may also be useful for reducing trace metals, complex organics, and providing a carbon matrix in the final effluent that is more similar to that found in natural streams. Due to the present regulatory environment, it is unlikely that the wetlands can be expanded at this time. However, the City plans to continue to use the existing wetlands as an effluent polishing treatment process.

7.9 ODOR CONTROL

The City requested that Carollo investigate covering of secondary clarifiers for odor concerns. While secondary clarifiers are not typically prime sources of odor in a wastewater treatment plant, some owners choose to cover the clarifiers for aesthetic reasons. For this evaluation, it was assumed that only the effluent weirs would be covered, as the hydraulic conditions at the weirs would promote the bulk of any released odor. A typical weir cover is shown on Figure 7.11 for a circular clarifier. The weir cover for a rectangular clarifier would require some additional elements to support it above the weir, as shown on Figure 7.12. In addition to the weir covers, the odor control system would include blowers to collect the headspace air, some form of odor control system such as a biofilter, and the required ducting. Additional evaluation of secondary clarifier odor control would be done during preliminary design if the City decides to pursue it further.

7.10 RETURN ACTIVATED SLUDGE/WASTE ACTIVATED SLUDGE PUMPING

Selection of RAS/WAS pumps is based on the flow and head characteristics of the RAS/WAS. Final selection of the pump types will be determined during preliminary design when the flow and head characteristics are known.

7.11 REFERENCE

Drury D, Clifton N., Todd A.C., Buhr H.O. and Moore T. Operating and Designing Municipal Wastewater Treatment Plants to Treat Toxicity, WEFTEC (October 1999), New Orleans, LA.

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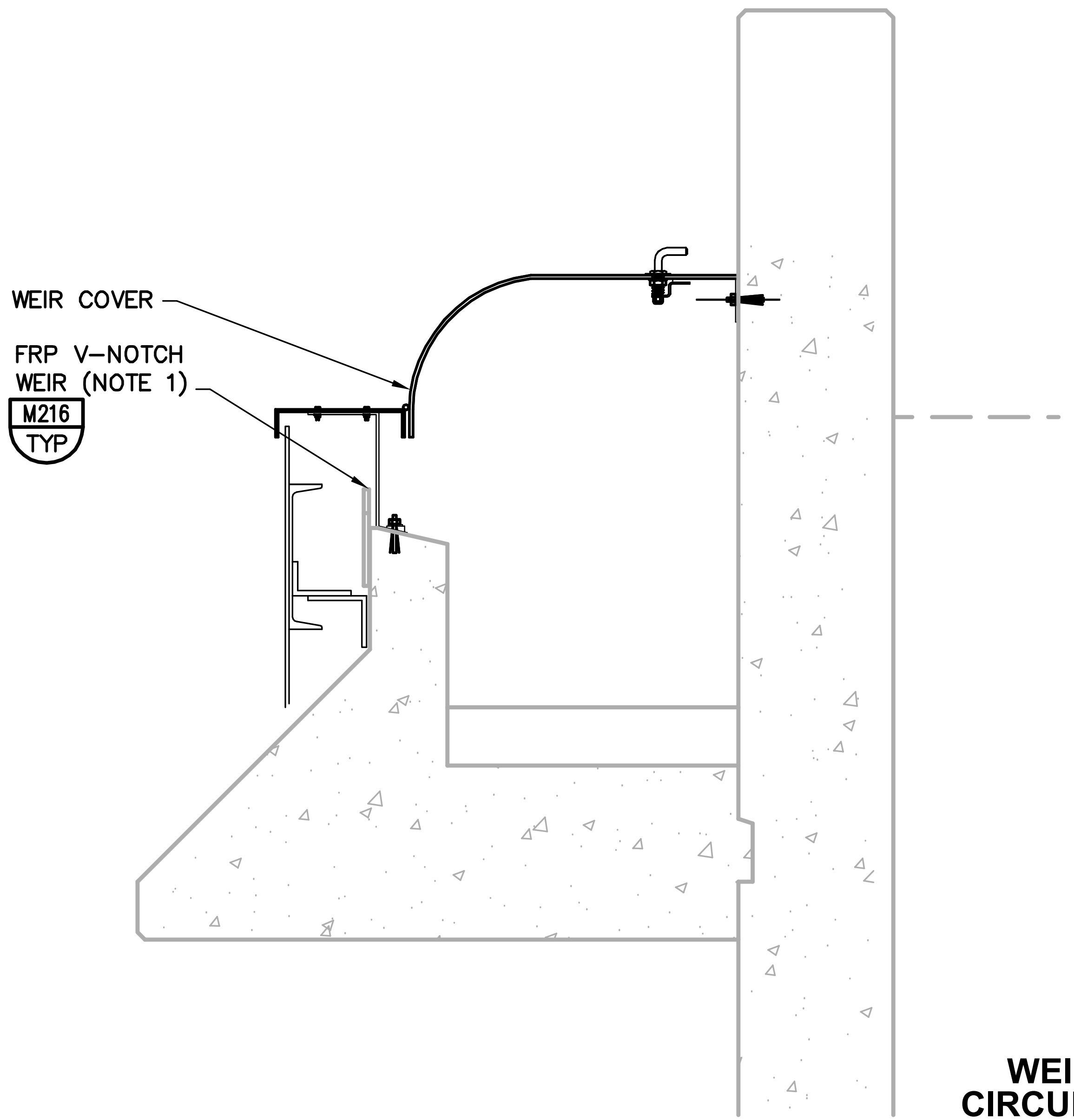
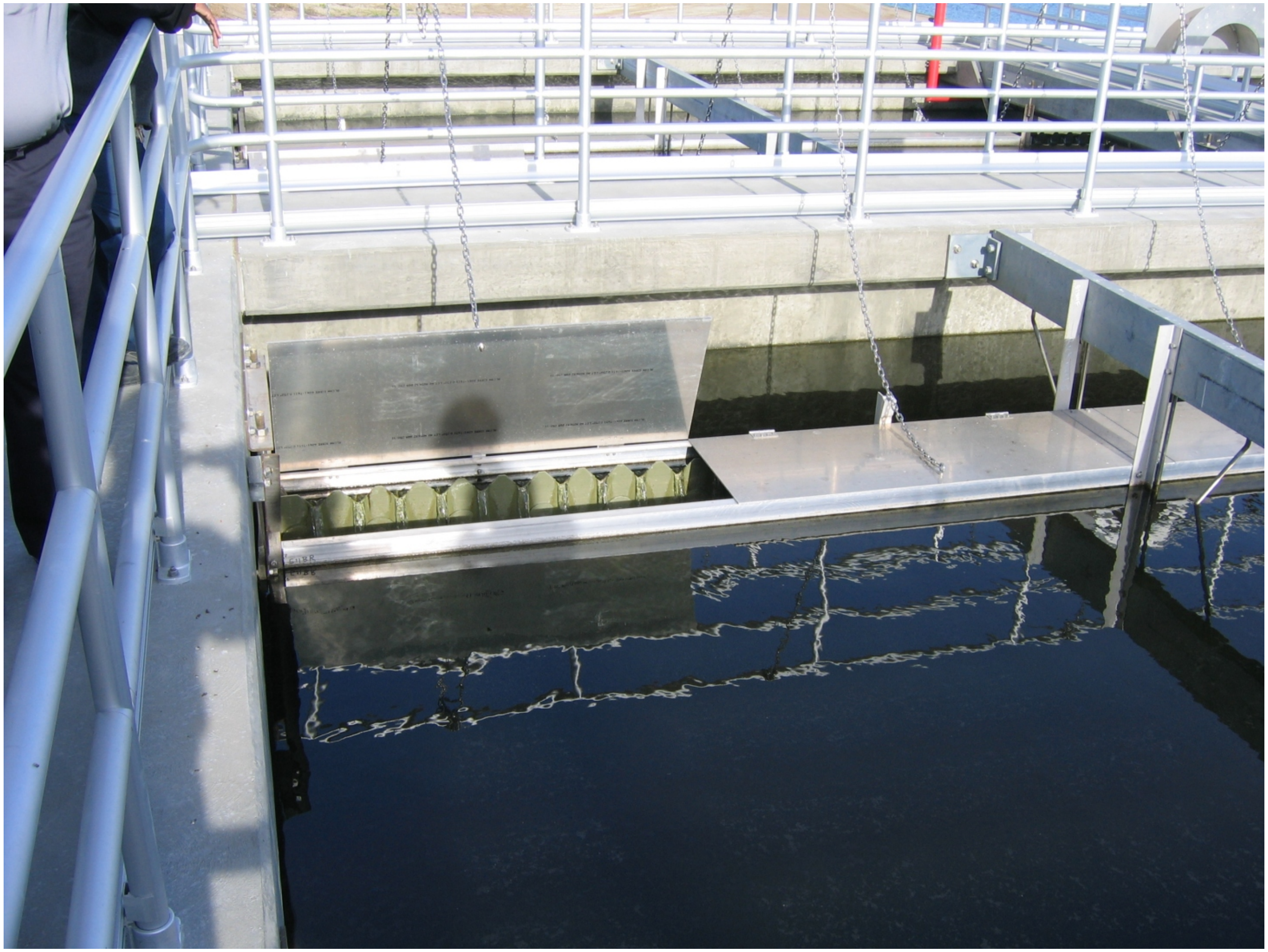


WEIR COVER FOR CIRCULAR CLARIFIERS

FIGURE 7.11



TYPICAL WEIR COVER FOR RECTANGULAR CLARIFIERS

FIGURE 7.12

BIOTRAN MODEL

CAROLLO ENGINEERS, PC

W.O./CLIENT: 7472A.00 / CITY OF RIVERSIDE
PROJECT: REGIONAL WATER QUALITY CONTROL PLANT -
SUBJECT: PROCESS ANALYSIS AND MASS BALANCE

Calc by: CFP,NV | Date Time: 02/27/2008 1:50 PM | Chk by/Date | FileName: Ch07-AppA.xls

Biotran05 v.1106

	Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd *	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd	35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
NOTES regarding this application:	With Better Sludge Settleability 60:40 Recycle Split Based on aeration capacity APAD Centrifuge, not BP			MBR With Better Sludge Settleability 80:20 Recycle Split Based on aeration capacity APAD Centrifuge, not BP			With Better Sludge Settleability 60:40 Recycle Split Based on aeration capacity APAD Centrifuge, not BP			With Better Sludge Settleability 30:70 Recycle Split Based on aeration capacity APAD Centrifuge, not BP				
SUMMARY:														
FLOW RATES, mgd:														
- Raw WW Flow	35.5	22.2		35.5	22.2		35.5	22.2		24.4	33.3			
- Flow to Primaries	40.6	25.6		39.3	23.2		41.0	25.9		26.9	39.0			
- Flow to Activated Sludge	39.2	25.3		37.8	23.0		39.1	25.0		26.0	38.4			
SECONDARY EFFLUENT QUALITY, mg/L:														
- BOD (est.), mg/L	2	2		1	2		2	2		2	2			
- TSS (nominal), mg/L	5	4		0	4		5	4		5	4			
- NH3-N, mg/L [Note]	0.26	0.40		0.24	0.29		0.46	0.87		0.19	0.42			
- NO3/NO2-N, mg/L	6.7	7.4		7.4	6.6		7.5	7.7		5.4	7.2			
- T.I.N., mg/L	7.0	7.8		7.6	6.9		8.0	8.6		5.6	7.7			
PRIMARY CLARIFIERS														
- # of Clarifiers	4	4		4	4		4	4		4	4			
- # in Service	4	4		4	4		4	4		4	4			
- Surface Overflow Rate, gpd/sf	897	902		869	817		907	913		948	1,376			
AERATION BASINS														
- # of Basins	12	6		13	6		8	6		6	6			
- # in Service	11	6		13	6		8	6		6	6			
- Hydraulic Deten. Time, hr	6.8	7.5		3.6	8.2		5.0	7.5		5.6	4.9			
- Operating Last-Pass MLSS, mg/L	3,500	2,500		10,000	2,500		3,500	2,500		5,500	4,500			
- Design Temperature, deg C	20.0	20.0		20.0	20.0		20.0	20.0		20.0	20.0			
- Unaerated Volume Fraction	0.25	0.40		0.45	0.40		0.50	0.60		0.25	0.40			Selected
- Aerobic SRT, days	5.95	3.52		5.23	4.08		4.41	3.93		8.13	3.39			
-- Min. Aerobic SRT for Nitrification	5.46	4.41		5.03	4.41		4.68	5.38		5.76	4.41			
- Total SRT, days	7.93	5.87		8.37	6.80		8.83	9.84		10.84	5.64			
-- Recommended Min. Total SRT for Nitrification	7.28	7.35		8.04	7.35		9.36	13.46		7.68	7.35			
- F/M, lb BOD Appl./lb MLSS-day	0.21	0.33		0.24	0.31		0.31	0.35		0.17	0.31			
- Aer. BOD Loading, lb BOD/1000 cf-day	47	52		127	49		67	55		58	88			
- ML Recirculation Ratio	2.5	2.0		3.2	2.2		2.5	2.0		2.3	2.0			Selected
- Process Air (est.), scfm	19,300	12,910		25,000	11,350		15,530	8,780		13,910	23,600			
MEMBRANE BIO-REACTOR														
- # of Membrane Zones (Basins)				8										
- # of Membrane Cassettes per Zone				18										
- Total Membrane Modules (Elements)				7,022										
- Total Membrane Area, sf				2,387,383										
- Average Operating Flux, gfd				15.6										
- Normal Daily Peak Flux, gfd				20.1										
-- One Membrane Zone Out of Service, gfd				23.0										
- Scrubbing Air Blowers Installed (1 standby)				9										
- Blower Capacity, each, scfm				1,200										
- Blower Motor Size, each, hp				60										

* Input Data

CAROLLO ENGINEERS, PC

W.O./CLIENT:	7472A.00 / CITY OF RIVERSIDE
PROJECT:	REGIONAL WATER QUALITY CONTROL PLANT -
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Calc by: CFP,NV Date Time: 02/27/2008 1:50 PM Chk by/Date FileName: Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
SECONDARY CLARIFIERS															
- # of Basins		7	4			4		7	4		4	5			
- # in Service		6	4			4		6	4		4	5			
- Sec. Clarifier SOR, gpd/sf		735	589			537		737	587		731	683			
- Sec. Clar. Solids Loading, lb/day-sf		29	16			15		29	16		54	37			
- Clarifier Safety Factor (CSF)		2.4	3.0			3.3		2.4	3.1		1.6	2.1			
-- CSF Target		2.3	2.3			2.3		2.3	2.3		2.3	2.3			

DETAILED CALCULATIONS:

		ASP Plant 1	ASP Plant 2	ASP Combined	MBR Plant 1	MBR Plant 2	MBR Combined	EPT Plant 1	EPT Plant 2	EPT Combined	IFAS Plant 1	IFAS Plant 2	IFAS Combined	Setup info	Basis
RAW WASTEWATER (excluding Recycles)															
o Plant Flow Rate, mgd		35.5	22.2		35.5	22.2		35.5	22.2		24.4	33.3			
o Flow Characteristic Ratios															
- Max Month/Annual Avg	*	1.11	1.11		1.11	1.11		1.11	1.11		1.11	1.11			Default
- Peak 4-hr Wet-W Flow/Annual Avg	*	**2.2**	**2.2**		**2.2**	**2.2**		**2.2**	**2.2**		**2.2**	**2.2**			Default
- Typical 4-hr Diurnal Peak/Daily Avg	*	1.3	1.3		1.3	1.3		1.3	1.3		1.3	1.3			Default
o Wastewater Characteristics															
- BOD, mg/L, Annual Average	*	**250**	**250**		**250**	**250**		**250**	**250**		**250**	**250**			Default
-- Mass Load (lb/d) Peaking Factor	*	1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective BOD, mg/L		282	282		282	282		282	282		282	282			
"Effective" concentrations correspond to Peak Mass Loads with the flow rate used in the calculation															
- TSS, mg/L, Annual Average	*	**250**	**250**		**250**	**250**		**250**	**250**		**250**	**250**			Default
-- Mass Load (lb/d) Peaking Factor	*	1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective TSS, mg/L		282	282		282	282		282	282		282	282			
- Fpv, VSS fraction	*	0.83	0.83		0.83	0.83		0.83	0.83		0.83	0.83			Default
-- Effective VSS, mg/L		234	234		234	234		234	234		234	234			
- NH3-N, mg/L, Annual Average	*	21.0	21.0		21.0	21.0		21.0	21.0		21.0	21.0			Default
-- Mass Load (lb/d) Peaking Factor	*	1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective NH3-N, mg/L		23.6	23.6		23.6	23.6		23.6	23.6		23.6	23.6			
Organic-N, mg/L, Annual Average	*	14.5	14.5		14.5	14.5		14.5	14.5		14.5	14.5			Default
-- Mass Load (lb/d) Peaking Factor	*	1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective Org-N, mg/L		16.3	16.3		16.3	16.3		16.3	16.3		16.3	16.3			
- NO3-N, mg/L, Annual Average	*	0	0		0	0		0	0		0	0			Default
- Alkalinity, mg/L, Annual Average	*	250	250		250	250		250	250		250	250			Default
- Filterable ("soluble") BOD															
-- fraction, Fbf	*	0.25	0.25		0.25	0.25		0.25	0.25		0.25	0.25			Default
-- mg/L		70	70		70	70		70	70		70	70			
- Fvu, Fraction VSS that is Unbiodeg	*	0.600	0.600		0.600	0.600		0.600	0.600		0.600	0.600			Estimated
- Total Phosphorus, mg/L, Annual Average	*	11.0	11.0		11.0	11.0		11.0	11.0		11.0	11.0			Default
-- Mass Load (lb/d) Peaking Factor	*	1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
-- Effective Total-P, mg/L		12.4	12.4		12.4	12.4		12.4	12.4		12.4	12.4			
-- Fraction filterable ("soluble")	*	0.32	0.32		0.32	0.32		0.32	0.32		0.32	0.32			Default
-- Filterable P, mg/L		3.94	3.94		3.94	3.94		3.94	3.94		3.94	3.94			
o Design Temperature, deg. C															
- Minimum (Winter)	*	20	20		20	20		20	20		20	20			Default
- Maximum (Summer)	*	29	29		29	29		29	29		29	29			Default
- Design	*	20	20		20	20		20	20		20	20			Winter
RECYCLE TO HEADWORKS/PRIM CLAR.S															
o Flow Rate, mgd															
- Filter Backwash	*	3.440	2.293	5.733	1.632	0.408	2.041	3.442	2.295	5.736	1.719	4.012	5.731		
- Dewatering Filtrate + Washwater/Centrate	*	0.163	0.108	0.271	0.216	0.054	0.269	0.166	0.110	0.276	0.080	0.187	0.268		

CAROLLO ENGINEERS, PC

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Primary Sludge Thickener Supernatant	*	1.450	0.967	2.417	1.954	0.488	2.442	1.902	1.268	3.170	0.646	1.508	2.154		
- Total		5.052	3.368		3.802	0.950		5.509	3.673		2.446	5.707			
o Wastewater Characteristics, mg/L															
- Total Recycle															
-- BOD		173	173		308	308		222	222		162	162			
-- TSS		301	301		510	510		342	342		288	288			
-- VSS		237	237		399	399		260	260		226	226			
-- NH3-N		66	66		116	116		57	57		66	66			
-- Organic-N		15	15		23	23		16	16		15	15			
-- NO3/NO2-N		5	5		3	3		5	5		5	5			
-- Alkalinity		378	378		559	559		343	343		378	378			
-- Filterable ("soluble") BOD		26.5	26.5		48.3	48.3		28.1	28.1		25.4	25.4			
-- Total soluble Organic N		3.0	3.0		3.5	3.5		3.1	3.1		3.0	3.0			
-- Fpv, VSS fraction		0.79	0.79		0.78	0.78		0.76	0.76		0.78	0.78			
- Fvu, Fraction VSS that is Unbiodeg	*	0.700	0.700		0.700	0.700		0.700	0.700		0.700	0.700			Default
PRIMARY TREATMENT		In Service	In Service		In Service	In Service		In Service	In Service		In Service	In Service			
o Flow Rate, mgd															
- Raw Wastewater		35.5	22.2		35.5	22.2		35.5	22.2		24.4	33.3			
- Recycle stream		5.05	3.37		3.80	0.95		5.51	3.67		2.45	5.71			
- Total Influent		40.6	25.6		39.3	23.2		41.0	25.9		26.9	39.0			
o Wastewater Characteristics, mg/L															
- BOD		268	267		284	283		274	273		271	264			
- TSS		284	284		304	291		290	290		282	282			
- VSS		234	234		250	240		237	237		233	232			
- NH3-N		29	29		33	27		28	28		28	30			
- Organic-N		16	16		17	17		16	16		16	16			
- NO3-N		1	1		0	0		1	1		0	1			
- Alkalinity		266	267		280	263		262	263		262	269			
- Filterable ("soluble") BOD		65	65		68	69		65	64		66	64			
- Fpv, VSS fraction		0.82	0.82		0.82	0.83		0.82	0.82		0.83	0.82			
o Basin dimensions (inside)															
- Basins Set - 1,2,3,4															
- Number of Basins	*	4	4		4	4		4	4		4	4			
- Number of Units in Service	*	4	4		4	4		4	4		4	4			
- Diameter, ft	*	120	95		120	95		120	95		95	95			
- Side Water Depth, ft	*	12	9		12	9		12	9		12	9			
- Surface Area per Basin, sf		11,310	7,088		11,310	7,088		11,310	7,088		7,088	7,088			
- Surface Area in Service, sf		45,239	28,353		45,239	28,353		45,239	28,353		28,353	28,353			
- Basins Set - 5,6															
- Number of Basins	*	0	0		0	0		0	0		0	0			
- Number of Units in Service	*	0	0		0	0		0	0		0	0			
- Diameter, ft	*	0	0		0	0		0	0		0	0			
- Side Water Depth, ft	*	9	0		9	0		9	0		9	0			
- Surface Area per Basin, sf		6,050	0		6,050	0		6,050	0		6,050	0			
- Surface Area in Service, sf		0	0		0	0		0	0		0	0			
- Total Surface Area in Service, sf		45,239	28,353		45,239	28,353		45,239	28,353		28,353	28,353			
o Surface Overflow Rate, gpd/sf															
- At Design Flow		897	902		869	817		907	913		948	1,376			
- At Diurnal Peak Flow		1,050	1,056		1,018	956		1,062	1,069		1,110	1,611			
- At Peak WW Flow		1,778	1,787		1,723	1,618		1,798	1,809		1,878	2,727			
o Detention Time, hr		2.4	1.8		2.5	2.0		2.4	1.8		2.3	1.2			
o Chemically Enhanced Primary Treatment															
- CEPT applied? [Y=1; N=0]	*	0	0		0	0		1	1		0	0			Default

* Input Data

CAROLLO ENGINEERS, PC

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Ferric Chloride dosage, mg/L as FeCl3	*	10	10		10	10		10	10		10	10			Default
-- FeCl3 used, lb/d		0	0		0	0		3,422	2,158		0	0			
- Polymer dosage, mg/L	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			Default
-- Polymer used, lb/d		0	0		0	0		0	0		0	0			
- Chem Sludge Generated, lb/d															
-- Total, lb/d		0	0		0	0		3,483	2,197		0	0			
- Alkalinity Reduction, mg/L		0	0		0	0		6	6		0	0			
o Removal Efficiency, %															
- BOD Removal, %		**40.3**	**40.3**		**40.7**	**41.5**		**59.0**	**58.9**		**39.6**	**33.5**			
- TSS Removal, %		**64.4**	**64.3**		**65.0**	**66.1**		**79.0**	**78.8**		**63.3**	**53.9**			
- Non-volatile SS %, Rpn		69.6	69.5		70.3	71.4		80.7	80.5		68.5	58.4			
- Organic-N Removal, %		46.5	46.4		47.4	47.6		56.7	56.6		45.6	39.2			
o Primary Sludge															
- Solids removed, lb/d															
-- Non-chemical primary solids		63,163	39,762		66,122	37,882		79,326	49,991		40,860	50,873			
-- Chemical solids from CEPT		0	0		0	0		3,483	2,197		0	0			
-- Total solids removed		63,163	39,762	102,925	66,122	37,882	104,003	82,809	52,188	134,997	40,860	50,873	91,734		
- Concentration, %	*	0.5	0.5		0.5	0.5		0.5	0.5		0.5	0.5			Default
- Flow Rate, mgd		1.515	0.954		1.586	0.908		1.986	1.252		0.980	1.220			
- Organic N removed, lb/d		2,654	1,670		2,757	1,592		3,263	2,054		1,723	2,150			
o Primary Effluent Flow, mgd		39.1	24.6		37.7	22.2		39.0	24.6		25.9	37.8			
o Primary Effluent, mg/L															
- BOD		160	160		168	165		112	112		163	175			
- TSS		101	101		106	99		61	61		104	130			
- VSS		86	86		90	84		51	51		88	109			
- NH3-N		29.0	29.3		32.6	27.4		28.1	28.3		27.5	29.8			
- Organic-N		8.66	8.66		8.93	8.70		7.03	7.04		8.81	9.78			
- NO3-N		0.6	0.7		0.3	0.1		0.7	0.7		0.4	0.7			
- Alkalinity		266	267		280	263		262	263		262	269			
- Filterable ("soluble") BOD		65	65		68	69		61	60		66	64			
RECYCLE TO ACTIVATED SLUDGE															
o Flow Rate, mgd															
- DAF Underflow	*	0.000	0.585	0.585	0.000	0.693	0.693	0.000	0.352	0.352	0.000	0.517	0.517		
- Stream 2	*	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
- Stream 3	*	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
- Spray Water to Basins	*	0.096	0.060		0.096	0.060		0.096	0.060		0.066	0.090			Default
- Total		0.096	0.645		0.096	0.753		0.096	0.412		0.066	0.607			
o Wastewater Characteristics, mg/L															
- Total Recycle															
-- BOD		0	191		0	156		0	174		0	217			
-- TSS		0	654		0	546		0	632		0	792			
-- VSS		0	553		0	461		0	531		0	664			
-- NH3-N		0	0		0	0		0	1		0	0			
-- Organic-N		0	44		0	36		0	42		0	51			
-- NO3-N		0	6		0	6		0	7		0	6			
-- Alkalinity		0	127		0	130		0	119		0	121			
-- Filterable ("soluble") BOD		0.0	1.0		0.0	1.0		0.0	0.9		0.0	1.0			
-- Total soluble Organic N		0.0	2.2		0.0	2.1		0.0	2.0		0.0	2.0			
-- Fpv, VSS fraction		0.00	0.85		0.84	0.84		0.00	0.84		0.00	0.84			
- Fvu, Fraction VSS that is Unbiodeg	*	0.700	0.700		0.700	0.700		0.700	0.700		0.700	0.700			Default
ACTIVATED SLUDGE PROCESS															

* Input Data

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT				Setup	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		info	
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0			
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7			
o Flow Rate, mgd																
- Main-Stream Influent		39.06	24.61		37.74	22.24		39.04	24.62		25.89	37.79				
- Recycle directly to AS		0.10	0.65		0.10	0.75		0.10	0.41		0.07	0.61				
- Total to Activated Sludge		39.15	25.26		37.83	22.99		39.14	25.03		25.95	38.39				
o Influent Characteristics, mg/L																
- Total BOD		160	161		168	165		112	113		163	176				
- TSS		101	116		106	113		61	71		103	141				
- VSS		86	98		90	97		51	59		88	118				
- NH3-N		29	29		32	27		28	28		27	29				
- Organic-N		9	10		9	10		7	8		9	10				
- NO3-N		1	1		0	0		1	1		0	1				
- Alkalinity		265	263		279	258		262	261		261	266				
- Filterable ("soluble") BOD		65	63		68	67		61	59		66	63				
- Fpv, VSS fraction		0.85	0.85		0.85	0.85		0.83	0.83		0.85	0.84				
- AB Influent D.O. Concentration, mg/L		0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0				
o Basin dimensions																
- Main Basins					MBR									**For MBR,**	MBR	
-- No. of Basins	*	12	6		5	6		8	6		6	6		enter	0	
-- Number of Units in Service	*	11	6		5	6		8	6		6	6		Basin	0	
-- Length, ft (inside)	*	200	250		200	250		200	250		200	250		dimen.s	0	
-- Width, ft (inside)	*	40	40		40	40		40	40		40	40		in the	0	
-- Side Water Depth, ft	*	16.9	17.5		16.9	17.5		16.9	17.5		16.9	17.5		MBR	0	
.. Recomm inside Wall height, incl. Freeboard, ft		19.9	20.5		22.9	20.5		19.9	20.5		19.9	20.5		section	3	
-- Liquid Volume per Basin, mil gal		1.01	1.31		1.01	1.31		1.01	1.31		1.01	1.31		(not HERE)	0.00	
- Supplemental Basins or Sections																
-- Identification	*				Membrn Zn									calcs	Membrn Zn	
-- No. of Basins	*	0	0		8	0		0	0		0	0			0	
-- Number of Units in Service	*	0	0		8	0		0	0		0	0		into	0	
-- Length, ft (inside)	*	200	200		19.5	200		200	200		200	200		< - - these	0	
-- Width, ft (inside)	*	40	100		75	100		40	100		40	100		columns	0	
-- Side Water Depth, ft	*	16.9	17		11.9	17		16.9	17		16.9	17			0	
-- Volume per Basin, mil gal		1.01	2.54		0.13	2.54		1.01	2.54		1.01	2.54			0.00	
o Total Volume of Basins, mil gal																
- Total Basin volume in service		11.12	7.85		6.10	7.85		8.09	7.85		6.07	7.85				
-- Reduction for MBR cassettes		0.00	0.00		0.41	0.00		0.00	0.00		0.00	0.00				
- Biological Reaction Volume		11.12	7.85		5.69	7.85		8.09	7.85		6.07	7.85				
o Aerated Zone BOD Loading, lb/1,000 cf-day		46.5	52.0		126.8	48.7		67.3	54.9		57.6	87.8				
o Hydraulic Detention Time, hr		6.82	7.46		3.61	8.20		4.96	7.53		5.61	4.91				
o Selected Operating L-P MLSS, mg/L		3,500	2,500		10,000	2,500		3,500	2,500		5,500	4,500				
PROCESS LAYOUT																
o Zone Sizes (Fraction of Total Volume)																Selected
- Zone 1	*	0.125	0.186		0.225	0.186		0.125	0.186		0.125	0.186		**For MBR,**	0.000	
- Zone 2	*	0.125	0.214		0.225	0.214		0.125	0.214		0.125	0.214		*Copy*	0.000	
- Zone 3	*	0.000	0.000		0.225	0.000		0.000	0.000		0.000	0.000		*& Paste*	0.000	
- Zone 4	*	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000		these - - >	0.000	
- Zone 5	*	0.250	0.200		0.000	0.200		0.250	0.200		0.250	0.200		calcs into	0.000	
- Zone 6	*	0.250	0.200		**0.225**	0.200		0.250	0.200		0.250	0.200		< - - these	0.000	
- Zone 7 (by difference)		0.250	0.200		0.100	0.200		0.250	0.200		0.250	0.200		columns	0.000	
-- Total		1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000			0.000	
o DO in each Zone (Unaerated, Set = 0), mg/L																
- Zone 1	*	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0		**For MBR,**	0.0	
- Zone 2	*	0.0	**0.0**		0.0	**0.0**		0.0	**0.0**		0.0	**0.0**		Adjust	2.0	
- Zone 3	*	0.0	2.0		**0.5**	2.0		0.0	0.0		0.0	2.0		D.O. as	2.0	

* Input Data

CAROLLO ENGINEERS, PC

W.O./CLIENT:	7472A.00 / CITY OF RIVERSIDE
PROJECT:	REGIONAL WATER QUALITY CONTROL PLANT -
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Calc by: CFP,NV — Date Time: 02/27/2008 1:50 PM — Chk by/Date — FileName: Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info		Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined			
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0			
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7			
- Zone 4	*	0.0	2.0		2.0	2.0		0.0	0.0		0.0	2.0		needed,	2.0	
- Zone 5	*	**0.2**	2.0		2.0	2.0		**0.0**	**0.0**		**0.1**	2.0		**except** for	2.0	
- Zone 6	*	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0		Zone 7	2.0	
- Zone 7	*	2.0	2.0		***1.5***	2.0		2.0	2.0		2.0	2.0		< - - copy	***0.0***	
o Aerated/Unaerated Fractions																
- Total Unaerated Volume Fraction		0.25	0.40		0.45	0.40		0.50	0.60		0.25	0.40				
-- Total Unaerated Volume, mil gal		2.78	3.14		2.56	3.14		4.05	4.71		1.52	3.14				
- Total Aerated Volume Fraction		0.75	0.60		0.55	0.60		0.50	0.40		0.75	0.60				
-- Total Aerated Volume, mil gal		8.34	4.71		3.13	4.71		4.05	3.14		4.55	4.71				
- Total Aerated Mass Fraction		0.75	0.60		0.63	0.60		0.50	0.40		0.75	0.60				
o Plant Influent Flow Routing																
- Fraction to Zone 1	*	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00				Default
- Fraction to Zone 2	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Fraction to Zone 3	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Fraction to Zone 4	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Fraction to Zone 5	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Remainder to Zone 6		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				
o Return Sludge Routing																
- Fraction to Zone 1	*	1.00	1.00		0.00	1.00		1.00	1.00		1.00	1.00				Default
- Fraction to Zone 2	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				Default
- Remainder to Zone 3		0.00	0.00		1.00	0.00		0.00	0.00		0.00	0.00				
o Mixed-Liquor Recirculation Routing																
- MLR Taken from Zone (3, 4, 5, 6, 7)	*	7	7		6	7		7	7		7	7				Default
- MLR Returned to Zone (1, 2, 3, 4, 5)	*	1	1		1	1		1	1		1	1				Default
- MLR Flow, mgd		96.00	50.00		120.00	50.00		96.00	50.00		60.00	75.00				
- MLR Ratio		2.45	1.98		3.17	2.17		2.45	2.00		2.31	1.95				
o Sludge Wasting Method														**For MBR,**		
- Wasting from RAS (1) or ML (0)	*	1	1		***0***	1		1	1		1	1		< - - copy	***0***	Default
-- If ML, Waste taken from Zone # (1, 2, - - 7)	*	(RAS)	(RAS)		*7*	(RAS)		(RAS)	(RAS)		(RAS)	(RAS)		< - - copy	*7*	Default
LOADING CRITERIA																
o BOD Applied, lb/d																
- Total Influent		52,109	33,813		53,012	31,643		36,531	23,652		35,290	56,403				
- (-) WAS Recycled		228	1,028		0	980		159	598		225	1,100				
- Net BOD Load		51,881	32,785		53,012	30,663		36,373	23,054		35,065	55,303				
o MLSS under aeration, lb		243,533	98,205		218,609	98,225		118,074	65,491		208,756	176,793				
- F/M, lb BOD Appl./lb MLSS-day		0.21	0.33		0.24	0.31		0.31	0.35		0.17	0.31				
o Organic Loading, Based on Aerated Zone																
- Aerated Volume in Service, 1,000 cf		1,115	630		418	630		541	420		608	630				
- Aer. BOD Loading, lb BOD/1000 cf-day		46.5	52.0		126.8	48.7		67.3	54.9		57.6	87.8				
o Unaerated Zone																
- Actual HRT (Throughflow), hr		0.45	0.91		0.39	0.94		0.66	1.36		0.36	0.58				
- Mixing Power, total																
-- Total BHP, all Unaerated Zones	*	97.3	110.0		89.6	110.0		141.6	164.9		53.1	110.0				
-- Mixing, hp/mil gal		35	35		35	35		35	35		35	35				
ACTIVATED SLUDGE - ZONE 1		Un-Aer	Un-Aer		Un-Aer	Un-Aer		Un-Aer	Un-Aer		Un-Aer	Un-Aer				
o Zone Volume, mil gal	1	1.391	1.461		1.280	1.461		1.011	1.461		0.758	1.461				
o Flows Entering, mgd	1															
- Plant Influent Flow	1	39.15	25.26		37.83	22.99		39.14	25.03		25.95	38.39				
- RAS Stream	1	13.01	7.99		0.00	7.27		13.01	7.91		15.66	16.87				
- Centrate	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00				
- ML Recirculation	1	96.00	50.00		120.00	50.00		96.00	50.00		60.00	75.00				

* Input Data

CAROLLO ENGINEERS, PC

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Calc by: CFP,NV Date Time: 02/27/2008 1:50 PM Chk by/Date FileName: Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	info	
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Total Flow to this Zone	1	148.17	83.25		157.83	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone, mgd	1														
- ML Recirculated to Other Zones	1	n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a			
- ML Wasted from this Zone	1	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	1	148.17	83.25		157.83	80.26		148.15	82.95		101.62	130.26			
o HRT in this Zone	1														
- Hydraulic Detention time, Actual, hr	1	0.23	0.42		0.19	0.44		0.16	0.42		0.18	0.27			
o Effluent from this Zone	1														
-- MLSS, mg/L	1	3,500	2,498		6,134	2,499		3,501	2,502		5,502	4,497			
-- NH3-N, mg/L	1	7.67	8.83		8.43	7.73		7.51	8.85		7.03	8.88			
-- NO3-N, mg/L	1	2.12	1.34		1.74	0.78		3.24	1.96		1.13	1.25			
-- D.O., mg/L	1	0.01	0.00		0.00	0.00		0.01	0.00		0.01	0.00			
o Biological Growth Summary	1														
- Increase in VSS, lb/d	1	5,943	3,690		5,537	3,568		5,713	3,672		3,974	5,455			
- Increase in ISS, lb/d	1	533	354		528	338		498	336		354	531			
ACTIVATED SLUDGE - ZONE 2		Un-Aer	Un-Aer		Un-Aer	Un-Aer		Un-Aer	Un-Aer		Un-Aer	Un-Aer			
o Zone Volume, mil gal	2	1.391	1.681		1.280	1.681		1.011	1.681		0.758	1.681			
o Flows Entering, mgd	2														
- Throughflow	2	148.17	83.25		157.83	80.26		148.15	82.95		101.62	130.26			
- Plant Influent to this Zone	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- RAS Stream	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Recirculation	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	2	148.17	83.25		157.83	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone, mgd	2														
- ML Recirculated to Other Zones	2	n/a	n/a		n/a	n/a		n/a	n/a		n/a	n/a			
- ML Wasted from this Zone	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	2	148.17	83.25		157.83	80.26		148.15	82.95		101.62	130.26			
o HRT in this Zone	2														
- Hydraulic Detention time, Actual, hr	2	0.23	0.48		0.19	0.50		0.16	0.49		0.18	0.31			
o Effluent from this Zone	2														
-- MLSS, mg/L	2	3,500	2,495		6,133	2,495		3,501	2,500		5,501	4,494			
-- NH3-N, mg/L	2	7.92	9.26		8.74	8.30		7.68	9.18		7.35	9.35			
-- NO3-N, mg/L	2	0.81	0.04		0.29	0.01		2.00	0.34		0.11	0.02			
-- D.O., mg/L	2	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
o Biological Growth Summary	2														
- Increase in VSS, lb/d	2	-480	-1,857		-2,178	-2,752		505	-845		-943	-3,546			
- Increase in ISS, lb/d	2	-4	-88		-118	-144		63	-33		-52	-177			
ACTIVATED SLUDGE - ZONE 3		N.I.S.	N.I.S.		Aerated	N.I.S.		N.I.S.	N.I.S.		N.I.S.	N.I.S.			
o Zone Volume, mil gal	3	0.000	0.000		1.280	0.000		0.000	0.000		0.000	0.000			
o Flows Entering, mgd	3														
- Throughflow	3	148.17	83.25		157.83	80.26		148.15	82.95		101.62	130.26			
- Plant Influent to this Zone	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- RAS Stream	3	0.00	0.00		151.33	0.00		0.00	0.00		0.00	0.00			
- ML Recirculation	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	3	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone, mgd	3														
- ML Recirculated to Other Zones	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Wasted from this Zone	3	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	3	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			

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Biotran05 v.1106		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
o HRT in this Zone	3														
- Hydraulic Detention time, Actual, hr	3	0.00	0.00		0.10	0.00		0.00	0.00		0.00	0.00			
o Effluent from this Zone	3														
-- MLSS, mg/L	3	3,500	2,495		8,026	2,495		3,501	2,500		5,501	4,494			
-- NH3-N, mg/L	3	7.92	9.26		2.72	8.30		7.68	9.18		7.35	9.35			
-- NO3-N, mg/L	3	0.81	0.04		5.26	0.01		2.00	0.34		0.11	0.02			
-- D.O., mg/L	3	0.00	0.00		0.50	0.00		0.00	0.00		0.00	0.00			
o Biological Growth Summary	3														
- Increase in VSS, lb/d	3	0	0		211	0		0	0		0	0			
- Increase in ISS, lb/d	3	0	0		426	0		0	0		0	0			
ACTIVATED SLUDGE - ZONE 4		N.I.S.	N.I.S.		N.I.S.	N.I.S.		N.I.S.	N.I.S.		N.I.S.	N.I.S.			
o Zone Volume, mil gal	4	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
o Flows Entering, mgd	4														
- Throughflow	4	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
- Plant Influent to this Zone	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Recirculation	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	4	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone, mgd	4														
- ML Recirculated to Other Zones	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Wasted from this Zone	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	4	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
o HRT in this Zone	4														
- Hydraulic Detention time, Actual, hr	4	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
o Effluent from this Zone	4														
-- MLSS, mg/L	4	3,500	2,495		8,026	2,495		3,501	2,500		5,501	4,494			
-- NH3-N, mg/L	4	7.92	9.26		2.72	8.30		7.68	9.18		7.35	9.35			
-- NO3-N, mg/L	4	0.81	0.04		5.26	0.01		2.00	0.34		0.11	0.02			
-- D.O., mg/L	4	0.00	0.00		0.50	0.00		0.00	0.00		0.00	0.00			
o Biological Growth Summary	4														
- Increase in VSS, lb/d	4	0	0		0	0		0	0		0	0			
- Increase in ISS, lb/d	4	0	0		0	0		0	0		0	0			
ACTIVATED SLUDGE - ZONE 5		Aerated	Aerated		N.I.S.	Aerated		Un-Aer	Un-Aer		Aerated	Aerated			
o Zone Volume, mil gal	5	2.781	1.571		0.000	1.571		2.023	1.571		1.517	1.571			
o Flows Entering, mgd	5														
- Throughflow	5	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
- Plant Influent to this Zone	5	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Recirculation	5	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	5	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone, mgd	5														
- ML Recirculated to Other Zones	5	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- ML Wasted from this Zone	5	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	5	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
o HRT in this Zone	5														
- Hydraulic Detention time, Actual, hr	5	0.45	0.45		0.00	0.47		0.33	0.45		0.36	0.29			
o Effluent from this Zone	5														
-- MLSS, mg/L	5	3,500	2,497		8,026	2,498		3,499	2,497		5,500	4,497			
-- NH3-N, mg/L	5	5.71	5.24		2.72	4.37		7.98	9.52		5.56	5.34			
-- NO3-N, mg/L	5	1.88	3.32		5.26	3.12		0.68	0.01		0.63	3.23			
-- D.O., mg/L	5	0.15	2.00		0.50	2.00		0.00	0.00		0.10	2.00			
o Biological Growth Summary	5														
- Increase in VSS, lb/d	5	-548	1,283		0	1,960		-2,260	-2,440		-857	2,399			

* Input Data

CAROLLO ENGINEERS, PC

W.O./CLIENT: 7472A.00 / CITY OF RIVERSIDE
PROJECT: REGIONAL WATER QUALITY CONTROL PLANT -
SUBJECT: PROCESS ANALYSIS AND MASS BALANCE

Calc by: CFP,NV Date Time: 02/27/2008 1:50 PM Chk by/Date: FileName: Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Increase in ISS, lb/d	5	318	341		0	372		-130	-128		158	596			
ACTIVATED SLUDGE - ZONE 6		Aerated	Aerated		Aerated	Aerated		Aerated	Aerated		Aerated	Aerated			
o Zone Volume, mil gal	6	2.781	1.571		1.280	1.571		2.023	1.571		1.517	1.571			
o Flows Entering, mgd	6														
- Throughflow	6	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
- Plant Influent to this Zone	6	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	6	148.17	83.25		309.16	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone, mgd	6														
- ML Recirculated to Other Zones	6	0.00	0.00		120.00	0.00		0.00	0.00		0.00	0.00			
- ML Wasted from this Zone	6	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net ML Flow to Next Zone, mgd	6	148.17	83.25		189.16	80.26		148.15	82.95		101.62	130.26			
o HRT in this Zone	6														
- Hydraulic Detention time, Actual, hr	6	0.45	0.45		0.10	0.47		0.33	0.45		0.36	0.29			
o Effluent from this Zone	6														
-- MLSS, mg/L	6	3,500	2,499		8,026	2,500		3,500	2,499		5,501	4,499			
-- NH3-N, mg/L	6	1.71	2.00		0.94	1.50		2.91	4.17		1.44	2.08			
-- NO3-N, mg/L	6	5.45	6.08		6.83	5.57		5.30	4.70		4.33	5.94			
-- D.O., mg/L	6	2.00	2.00		2.00	2.00		2.00	2.00		2.00	2.00			
o Biological Growth Summary	6														
- Increase in VSS, lb/d	6	437	902		661	626		496	1,499		38	1,654			
- Increase in ISS, lb/d	6	417	295		482	248		302	272		270	522			
ACTIVATED SLUDGE - ZONE 7		Aerated	Aerated		MBR	Aerated		Aerated	Aerated		Aerated	Aerated			
o Zone Volume, mil gal	7	2.781	1.571		0.567	1.571		2.023	1.571		1.517	1.571			
o Flows Entering, mgd	7														
- Throughflow	7	148.17	83.25		189.16	80.26		148.15	82.95		101.62	130.26			
- (-) Removed as MBR Filtrate [Note]	7	0.00	0.00		-37.33	0.00		0.00	0.00		0.00	0.00			
- Total Flow to this Zone	7	148.17	83.25		151.83	80.26		148.15	82.95		101.62	130.26			
o ML Flow removed from this Zone (excl.MBR Filtr)	7														
- ML Recirculated to Other Zones	7	96.00	50.00		0.00	50.00		96.00	50.00		60.00	75.00			
- ML Wasted from this Zone	7	0.00	0.00		0.50	0.00		0.00	0.00		0.00	0.00			
- Other ML Flow removed from this Zone	*	0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
- Net Flow to Next Zone, mgd	7	52.17	33.25		151.33	30.26		52.15	32.95		41.62	55.26			
o HRT in this Zone	7														
- Hydraulic Detention time, Actual, hr	7	0.45	0.45		0.09	0.47		0.33	0.45		0.36	0.29			
o Effluent from this Zone	7														
-- MLSS, mg/L	7	3,500	2,500		10,000	2,500		3,500	2,500		5,500	4,500			
-- NH3-N, mg/L	7	0.26	0.40		0.24	0.29		0.46	0.87		0.19	0.42			
-- NO3-N, mg/L	7	6.72	7.39		7.37	6.57		7.51	7.72		5.41	7.24			
-- D.O., mg/L	7	2.00	2.00		1.50	2.00		2.00	2.00		2.00	2.00			
o Biological Growth Summary	7														
- Increase in VSS, lb/d	7	-620	439		90	86		96	411		-671	1,066			
- Increase in ISS, lb/d	7	317	249		254	194		281	181		211	472			
WAS SOLIDS PRODUCTION															
o P-Removal															
- Include P-Removal in Calc? (Y=1, N=0)	*	0	0		0	0		0	0		0	0			
o Solids Production, TSS, lb/d															
- TSS Entering in Feed, lb/d		35,193	25,785		35,882	22,988		21,534	15,894		23,794	47,222			
- VSS Change in A.B. Zones		4,732	4,456		4,321	3,489		4,551	2,297		1,542	7,028			
- ISS Change in A.B. Zones		1,581	1,151		1,572	1,008		1,014	629		941	1,944			
- ISS due to Bio-P (Est.), lb/d		0	0		0	0		0	0		0	0			
- Unbiodeg VSS due to Bio-P (Est.), lb/d		0	0		0	0		0	0		0	0			

* Input Data

CAROLLO ENGINEERS, PC

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CFP,NV 02/27/2008 1:50 PM Ch07-AppA.xls

Biotran05 v.1106

	Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd *	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd	35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Total Solids Production, lb/d	**41,506**	**31,392**		**41,775**	**27,485**		**27,098**	**18,820**		**26,277**	**56,195**			
MLSS CHARACTERISTICS														
o Mixed Liquor Components, mg TSS/L														
- Solids, mg TSS/L														
-- Slowly Biodegradable	26	28		86	23		28	21		34	51			
-- Active Biomass	1,261	996		3,526	977		1,238	838		1,723	1,661			
-- Endogenous Biomass	415	206		1,180	230		406	255		758	345			
-- Nitrifiers	59	44		182	41		91	63		81	67			
-- Unbiodegradable VSS (Influent + Bio-P)	1,196	881		3,443	887		1,185	947		2,020	1,686			
-- Inorganic SS (influent + Biogrowth)	550	384		1,585	383		557	410		897	732			
-- Inorganic SS due to Bio-P (est.)	0	0		0	0		0	0		0	0			
-- Total Last-Pass MLSS	3,506	2,539		10,002	2,542		3,506	2,535		5,514	4,541			
-- Total Soluble Organic N (SolOrgN)	2.3	2.4		2.3	2.3		2.3	2.4		2.3	2.4			
-- Alkalinity, mg/L as CaCO3	141.2	139.2		138.6	142.2		139.0	139.7		145.8	139.8			
o Org N fraction of MLVSS (NinVSS)	0.079	0.081		0.078	0.081		0.079	0.079		0.077	0.078			
o MLVSS Fraction	0.84	0.85		0.84	0.85		0.84	0.84		0.84	0.84			
o BOD of AS Solids														
- BOD/TSS ratio	0.28	0.31		0.28	0.30		0.28	0.26		0.24	0.29			
SOLIDS RETENTION TIME, SRT														
o Total Solids Wasted, lb/d	41,506	31,392		41,775	27,485		27,098	18,820		26,277	56,195			
- Recycled WAS Solids, lb/d	582	3,522		0	3,425		343	2,173		600	4,007			
- Net lb Solids Yield/day	40,924	27,870		41,775	24,060		26,755	16,646		25,677	52,188			
o Total BOD Load, lb/d	51,881	32,785		53,012	30,663		36,373	23,054		35,065	55,303			
- Recycled BOD, lb/d	228	1,028		0	980		159	598		225	1,100			
- Net BOD Load, lb/d	51,653	31,757		53,012	29,684		36,214	22,456		34,841	54,203			
o Solids Production														
- lb Dry SS/lb BOD Applied	0.792	0.878		0.788	0.811		0.739	0.741		0.737	0.963			
o Total Mass TSS in System, lb	324,711	163,609		349,539	163,644		236,149	163,723		278,358	294,577			
- **Total SRT (Rs), days**	**7.93**	**5.87**	**7.24**	**8.37**	**6.80**	**7.87**	**8.83**	**9.84**	**9.24**	**10.84**	**5.64**	**8.17**		
- lb/mgd	8,293	6,477		9,239	7,117		6,034	6,540		10,726	7,673			
o Total Mass TSS in Aerated Zones, lb	243,533	98,205		218,609	98,225		118,074	65,491		208,756	176,793			
- Nominal Aerated Mass Fraction	0.750	0.600		0.625	0.600		0.500	0.400		0.750	0.600			
- **Nominal Aerobic SRT, days**	**5.95**	**3.52**		**5.23**	**4.08**		**4.41**	**3.93**		**8.13**	**3.39**			
o Mass Fraction in Each Zone														
- Zone 1	0.125	0.186		0.187	0.186		0.125	0.186		0.125	0.186			
- Zone 2	0.125	0.214		0.187	0.214		0.125	0.214		0.125	0.214			
- Zone 3	0.000	0.000		0.245	0.000		0.000	0.000		0.000	0.000			
- Zone 4	0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
- Zone 5	0.250	0.200		0.000	0.200		0.250	0.200		0.250	0.200			
- Zone 6	0.250	0.200		0.245	0.200		0.250	0.200		0.250	0.200			
- Zone 7	0.250	0.200		0.135	0.200		0.250	0.200		0.250	0.200			
	1.000	1.000		1.000	1.000		1.000	1.000		1.000	1.000			
o Min. Aer. SRT recommended for nitrification, days	5.5	4.4		5.0	4.4		4.7	5.4		5.8	4.4			
- Washout SRT(total)														
-- Rwashout = 1/(Ua*DOsw - ba)	3.16	3.20		3.56	3.20		4.28	6.52		3.37	3.20			
- Recommended Aerobic SRT														
-- Max slope criterion, dNH3/dSRT, mg/L-d *	0.20	0.20		0.20	0.20		0.20	0.20		0.20	0.20			
-- Recomm. Min. Operating SRT(total)	7.3	7.4		8.0	7.4		9.4	13.5		7.7	7.4			
-- Recomm. Min. Operating SRT(Nominal aerobic)	5.5	4.4		5.0	4.4		4.7	5.4		5.8	4.4			
-- Nitrification Safety Factor	2.31	2.30		2.26	2.30		2.19	2.06		2.28	2.30			

* Input Data

CAROLLO ENGINEERS, PC

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
AERATION REQUIREMENTS															
o Oxygen Required, lb/d															
- Net Oxygen Demand in Zone 1		0	0		0	0		0	0		0	0			
- Net Oxygen Demand in Zone 2		0	0		0	0		0	0		0	0			
- Net Oxygen Demand in Zone 3		0	0		32,850	0		0	0		0	0			
- Net Oxygen Demand in Zone 4		0	0		0	0		0	0		0	0			
- Net Oxygen Demand in Zone 5		21,855	19,647		0	18,910		257	331		13,151	31,512			
- Net Oxygen Demand in Zone 6		37,129	16,293		38,026	14,599		38,401	22,395		26,548	26,362			
- Net Oxygen Demand in Zone 7		21,810	11,582		12,182	9,948		22,983	15,185		14,952	19,338			
- (-) Oxygen provided by MBR Scouring		0	0		-10,220	0		0	0		0	0			
- Total Oxygen required lb/d		**80,794**	**47,522**		**72,838**	**43,458**		**61,641**	**37,911**		**54,651**	**77,212**			
o Diffuser Analysis		**42,715**	**58,144**					**42,715**	**58,144**		**42,715**	**58,144**			
Note:															
All values of air and blower requirements given below are preliminary estimates, to be refined during detailed design															
o Oxygen Transfer Efficiency		[EDI]	[EDI]		[EDI]	[EDI]		[EDI]	[EDI]		[EDI]	[EDI]			
- Diffuser Type		Mini-Panel	Mini-Panel		Mini-Panel	Mini-Panel		Mini-Panel	Mini-Panel		Mini-Panel	Mini-Panel			
- Aeration Basin D.O. (Avg), mg/L		1.4	2.0		1.3	2.0		2.0	2.0		1.4	2.0			
- Design Water Temperature, C		29	29		29	29		29	29		29	29			Summer
- Diffuser submergence, ft		15.9	16.5		15.9	16.5		15.9	16.5		15.9	16.5			
- Air loading, scfm/unit [Note]		1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
		scfm/sf	scfm/sf		scfm/sf	scfm/sf		scfm/sf	scfm/sf		scfm/sf	scfm/sf			
- Floor Coverage		23.4	28.7		70.3	25.2		38.8	29.3		30.9	52.4			
		%Actv A	%Actv A		%Actv A	%Actv A		%Actv A	%Actv A		%Actv A	%Actv A			
- Clean Water SOTE	*	36.2	37.1		36.2	37.1		36.2	37.1		36.2	37.1			Mfr. lit.
- Site Conditions Adjustment Factor															
F = Actual / Standard OTE															
-- Alpha factor, including fouling		0.54	0.50		0.37	0.52		0.56	0.59		0.50	0.45			Estimate
-- Theta factor	*	1.024	1.024		1.024	1.024		1.024	1.024		1.024	1.024			Default
-- Temp. correction, Tau		0.85	0.85		0.85	0.85		0.85	0.85		0.85	0.85			
-- Elevation above MSL, ft	*	695	695		695	695		695	695		695	695			Site
-- ..Pressure correction, Omega		0.97	0.97		0.97	0.97		0.97	0.97		0.97	0.97			
-- Beta factor	*	0.99	0.99		0.99	0.99		0.99	0.99		0.99	0.99			Default
-- Equilibrium C*20		10.64	10.70		10.64	10.70		10.64	10.70		10.64	10.70			
..Depth Adjustment Factor	*	0.37	0.37		0.37	0.37		0.37	0.37		0.37	0.37			Default
- F = Alpha x [Theta ^(T-20)] x (Tau Beta Omega C*20 - C)/C*20		0.46	0.39		0.32	0.41		0.43	0.46		0.43	0.35			
- Oxygen Transfer Efficiency		16.57	14.57		11.53	15.16		15.71	17.09		15.55	12.95			
OTE = F x SOTE		Percent	Percent		Percent	Percent		Percent	Percent		Percent	Percent			
Preliminary Estimate															
o Surface Aerators		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A		#N/A	#N/A			
- Oxygen to be transferred, lb/hr															
- Aerator hp required [Ox. Requ.d/Eff.]															
- Peaking factor	*														
- Aerator hp Installed															
o SOTR Required															
- Average Day @ Design flow															
-- Actual Ox Tr Requd, AOTR, lb/d		80,794	47,522		72,838	43,458		61,641	37,911		54,651	77,212			
-- Site Conditions Adjustment, F		0.46	0.39		0.32	0.41		0.43	0.46		0.43	0.35			
-- Standard Ox Tr Rate, SOTR, lb/d		176,639	121,066		228,813	106,388		142,119	82,336		127,308	221,242			
SOTR = AOTR / F															

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
o Air Supply Required															
- Average Day @ Design flow															
-- Ox Transfer Rate, AOTR, lb/d		80,794	47,522		72,838	43,458		61,641	37,911		54,651	77,212			
-- Oxygen Supplied, lb/min		338.6	226.5		438.6	199.1		272.4	154.1		244.0	414.0			
-- cf Air/lb Oxygen		57.0	57.0		57.0	57.0		57.0	57.0		57.0	57.0			
[23.3 lb O2/100 lb Air]															
[0.0753 lb Air/scf]															
-- Process Air, scfm		19,300	12,910		25,000	11,350		15,530	8,780		13,910	23,600			
..scfm per lb/d Oxygen		0.239	0.272		0.343	0.261		0.252	0.232		0.255	0.306			
..scf/lb BOD Applied		536	567		679	533		615	548		571	615			
-- Other Uses, e.g. Channel Air	*	1,500	1,200		1,500	1,200		1,500	1,200		1,200	1,400			Default
-- Total Blower Air, scfm		20,800	14,110		26,500	12,550		17,030	9,980		15,110	25,000			
- Peak Day @ Design Flow															
-- Peaking factor	*	1.3	1.3		1.3	1.3		1.3	1.3		1.3	1.3			Default
-- Process Air, scfm		25,100	16,800		32,500	14,800		20,200	11,400		18,100	30,700			
-- Total Blower Air, scfm		26,600	18,000		34,000	16,000		21,700	12,600		19,300	32,100			
o Diffusers															
- Expressed as active sq ft or # diffusers		sq ft	sq ft		sq ft	sq ft		sq ft	sq ft		sq ft	sq ft			
- Recommended															
-- Air Loading, scfm/(sf or dfr)		1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
-- Number recommended per Basin		1,403	1,722		4,000	1,513		1,553	1,171		1,854	3,146			
- Actual Installed, per basin															
-- Main Basin	*	1,403	1,722		4,000	1,513		1,553	1,171		1,854	3,146			
-- Additional Basin	*	0	0		0	0		0	0		0	0			
- Total Installed, sf or dfr		15,438	10,330		19,998	9,078		12,421	7,025		11,126	18,878			
- Air Loading, scfm/sf or dfr															
-- Daily Average		1.25	1.25		1.25	1.25		1.25	1.25		1.25	1.25			
- Floor Coverage															
-- Total Basin Floor Area in Service, sf		88,000	60,000		51,700	60,000		64,000	60,000		48,000	60,000			
-- Total Aerated Floor Area in service		66,000	36,000		28,427	36,000		32,000	24,000		36,000	36,000			
-- Coverage		23.4	28.7		70.3	25.2		38.8	29.3		30.9	52.4			
.. Expressed as		%Actv A	%Actv A		%Actv A	%Actv A		%Actv A	%Actv A		%Actv A	%Actv A			
- Active sf/diffuser, or 1		2.54	2.54		2.54	2.54		2.54	2.54		2.54	2.54			
- Number of diffuser units		6,078	4,067		7,873	3,574		4,890	2,766		4,380	7,432			
o Blower Discharge pressure															
- Head, ft water															
-- Submergence		15.9	16.5		15.9	16.5		15.9	16.5		15.9	16.5			
-- Freeboard above normal op level		0.0	0.0		4.0	0.0		0.0	0.0		0.0	0.0			
-- Diffuser head loss		1.5	1.5		1.5	1.5		1.5	1.5		1.5	1.5			
-- Pipe & Valve friction		2.5	2.5		2.5	2.5		2.5	2.5		2.5	2.5			
-- Total Head, ft		19.9	20.5		23.9	20.5		19.9	20.5		19.9	20.5			
- Discharge pressure, psig		8.6	8.9		10.4	8.9		8.6	8.9		8.6	8.9			
o Delivered Horsepower															
- Max Operating Air Temp, C	*	34	34		34	34		34	34		34	34			Default
- Barometric Pressure, psia		14.3	14.3		14.3	14.3		14.3	14.3		14.3	14.3			
- Blower Suction Pressure, psia		14.0	14.0		14.0	14.0		14.0	14.0		14.0	14.0			
- Daily Average Total Air, scfm		20,800	14,110		26,500	12,550		17,030	9,980		15,110	25,000			
- Avg Delivered Horsepower, hp		738	513		1,091	456		604	363		536	909			
- Peak Day Delivered hp		944	655		1,400	582		770	458		685	1,167			
o Wire power required															
- Energy Efficiency, %	*	61.0	61.0		61.0	61.0		61.0	61.0		61.0	61.0			Default
- Wire power required, hp															
-- Daily Average		1,210	840		1,790	750		990	590		880	1,490			
-- Firm Installed		1,550	1,070		2,290	950		1,260	750		1,120	1,910			

* Input Data

CAROLLO ENGINEERS, PC

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Calc by: CFP,NV Date Time: 02/27/2008 1:50 PM Chk by/Date FileName: Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
SECONDARY SEDIMENTATION BASINS															
o Flow Rates, mgd															
- AS Influent, Q		39.15	25.26		37.83	22.99		39.14	25.03		25.95	38.39			
- Net Sed. Basin Inflow (excl. RAS), Qci		39.15	25.26		37.33	22.99		39.14	25.03		25.95	38.39			
- Return Sludge Flow, Qr		13.01	7.99		151.33	7.27		13.01	7.91		15.66	16.87			
(not including waste sludge flow)															
- Total Sed Basin Inflow		52.17	33.25		188.66	30.26		52.15	32.95		41.62	55.26			
- Total Sed. Basin Underflow		13.36	8.35		151.33	7.59		13.23	8.13		15.87	17.33			
- Net Sec. Effluent, Qe		38.80	24.89		37.33	22.67		38.92	24.82		25.74	37.93			
o Basin dimensions															
- Group 1	*														
-- No. of Basins	*	7	2		8	2		7	2		4	**3**	1 more for		
-- Number of Units in Service	*	6	2		7	2		6	2		4	**3**	hydraulics		
-- Diameter, ft (inside)	*	0	130		0	130		0	130		0	130			
-- Side Water Depth, ft	*	11.9	14.0		11.9	14.0		11.9	14.0		11.9	14.0			
-- Surface Area per Basin, sf		8,800	13,273		8,800	13,273		8,800	13,273		8,800	13,273			
-- Volume per Basin, cf		104,720	185,825		104,720	185,825		104,720	185,825		104,720	185,825			
- Group 2	*														
-- No. of Basins	*	0	2		0	2		0	2		0	2			
-- Number of Units in Service	*	0	2		0	2		0	2		0	2			
-- Diameter, ft (inside)	*	120	100		120	100		120	100		120	100			
-- Side Water Depth, ft	*	14.0	10.3		14.0	10.3		14.0	10.3		14.0	10.3			
-- Surface Area per Basin, sf		11,310	7,854		11,310	7,854		11,310	7,854		11,310	7,854			
-- Volume per Basin, cf		158,336	80,503		158,336	80,503		158,336	80,503		158,336	80,503			
o Flow Split															
- Fraction of ML Flow to Group 1:															
-- Fraction based on Surface Area		1.00	0.63		1.00	0.63		1.00	0.63		1.00	0.72			
-- Fraction selected	*	1.00	0.63		1.00	0.63		1.00	0.63		1.00	0.72			
- Effective (Flow-weighted) SWD, ft		11.90	12.61		11.90	12.61		11.90	12.61		11.90	12.94			
o Surface Overflow Rate															
- Group 1															
-- Surface Area in service, sf		52,800	26,546		61,600	26,546		52,800	26,546		35,200	39,820			
-- Surface Overflow Rate, gpd/sf		735	589		606	537		737	587		731	683			
- Group 2															
-- Surface Area in service, sf		0	15,708		0	15,708		0	15,708		0	15,708			
-- Surface Overflow Rate, gpd/sf		0	589		0	537		0	587		0	683			
o Solids Loading Rate, lb/day-sf															
- Group 1		29	16		255	15		29	16		54	37			
- Group 2		0	16		0	15		0	16		0	37			
o Volume in service, mil gal															
- Group 1		4.70	2.78		5.48	2.78		4.70	2.78		3.13	4.17			
- Group 2		0.00	1.20		0.00	1.20		0.00	1.20		0.00	1.20			
o Hydraulic Detention Time, hr (based on Q)															
- Group 1		2.9	4.2		N.A.	4.6		2.9	4.2		2.9	3.6			
- Group 2		N.A.	3.1		N.A.	3.4		N.A.	3.1		N.A.	2.7			
o Weir Loading															
- Group 1															
-- Actual weir length per unit, ft	*	808	745		667	745		811	745		804	745			Default
-- Weir loading, gpd/ft		8,000	10,502		8,000	9,566		8,000	10,472		8,000	12,179			
- Group 2															
-- Actual weir length per unit, ft	*	0	556		0	556		0	556		0	556			Default
-- Weir loading, gpd/ft		0	8,320		0	7,579		0	8,297		0	9,649			
o Sludge Settling Characteristics															

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Design Max. SVI, ml/g	*	150	150		150	150		150	150		150	150			Default
ISV = a x exp(-b MLSS), ft/h															
- "a" Value, ft/hr	*	21.3	21.3		21.3	21.3		21.3	21.3		21.3	21.3			
- "b" Value [x 1,000,000]	*	218	218		218	218		218	218		218	218			
o Target Settling Values															
- Effluent rise rate (SOR), ft/hr															
-- Group 1		4.09	3.28		3.38	2.99		4.11	3.27		4.07	3.81			
-- Group 2		N.A.	3.28		N.A.	2.99		N.A.	3.27		N.A.	3.81			
-- Average		4.09	3.28		3.38	2.99		4.11	3.27		4.07	3.81			
- Clarifier Safety Factor, CSF	*	2.3	2.3		2.3	2.3		2.3	2.3		2.3	2.3			Default
- Initial Settling Velocity, ISV, ft/hr		9.3	7.5		7.7	6.8		9.4	7.5		9.3	8.7			
- Preferred Max. Last-Pass MLSS, mg/L		3,786	4,801		4,671	5,229		3,773	4,814		3,809	4,121			
o Selected Settling Values															
- Operating L-P MLSS conc, mg/L		3,500	2,500		10,000	2,500		3,500	2,500		5,500	4,500			
- Operating ISV, ft/h		9.9	12.4		2.4	12.4		9.9	12.4		6.4	8.0			
- Operating CSF															
-- Group 1		2.4	3.0		0.7	3.3		2.4	3.1		1.6	2.1			
-- Group 2		N.A.	3.0		N.A.	3.3		N.A.	3.1		N.A.	2.1			
MEMBRANE BIO-REACTOR (MBR)															
o MBR System in Service? (Y=1; N=0)	*	0	0		1	0		0	0		0	0			
into column B) but DO NOT DELETE the section															
o Flow Rates, mgd															
- Nominal Plant Flow Rate, mgd															
-- Daily Average		35.52	22.20		35.52	22.20		35.52	22.20		24.42	33.30			
-- 4-Hour Diurnal Peak Flow, mgd		46.18	28.86		46.18	28.86		46.18	28.86		31.75	43.29			
-- Max Instantaneous Flow, mgd		70.40	44.00		70.40	44.00		70.40	44.00		48.40	66.00			
- Actual Secondary Effluent, mgd															
-- Daily Average		38.80	24.89		37.33	22.67		38.92	24.82		25.74	37.93			
-- 4-Hour Diurnal Peak Flow, mgd		49.46	31.55		47.99	29.33		49.57	31.48		33.07	47.92			
-- Max Instantaneous Flow, mgd		73.68	46.69		72.21	44.47		73.80	46.62		49.72	70.63			
- Design Flow through Membranes															
-- Daily Average		38.80	24.89		37.33	22.67		38.92	24.82		25.74	37.93			
-- Peak Flow (Short Term)	*	49.46	31.55		47.99	29.33		49.57	31.48		33.07	47.92			
o Reaction Zone dimensions															
- (NOT INCLUDING the membrane zones)															
- No. of Units (parallel trains)	*	2	2		5	2		2	2		2	2			
- Number of Units in Service	*	2	2		5	2		2	2		2	2			
- Length, ft (inside)	*	200	200		200	200		200	200		200	200			
- Width, ft (inside)	*	100	100		40	100		100	100		100	100			
- Side Water Depth, ft	*	17	17		16.9	17		17	17		17	17			
- Volume per Basin, mil gal		2.54	2.54		1.01	2.54		2.54	2.54		2.54	2.54			
o Membrane System Characteristics															
- Membrane identification		ZW-500b	ZW-500b		ZW-500d	ZW-500b		ZW-500b	ZW-500b		ZW-500b	ZW-500b			
- Average Operating Flux, gfd	*	14	14		15.44	14		14	14		14	14			
- Stressed Operating Flux (4 hours), gfd	*	18.2	18.2		27.35	18.2		18.2	18.2		18.2	18.2			
- Membrane area per module (element), sf	*	650	650		340	650		650	650		650	650			
- Modules (Elements) per Cassette	*	8	8		48	8		8	8		8	8			
- Cassette dimensions, ft															
-- Length	*	6	6		7.1	6		6	6		6	6			
-- Width	*	2.39	2.39		5.7	2.39		2.39	2.39		2.39	2.39			
-- Depth (Height)	*	6.73	6.73		8.3	6.73		6.73	6.73		6.73	6.73			
Scrubbing air, acfm per sf membrane	*	0.0192	0.0192		0.0128	0.0192		0.0192	0.0192		0.0192	0.0192			
-- acfm per module		12.48	12.48		4.35	12.48		12.48	12.48		12.48	12.48			

* Input Data

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
-- Percent of time that air is ON	*	100	100		25	100		100	100		100	100			
-- Net scfm per module		14.7	14.7		1.3	14.7		14.7	14.7		14.7	14.7			
o Est.Membrane Units Required (*In Service*)															
- Membrane Area, sf															
-- Based on Avg Flux		2,771,653	1,777,953		2,072,197	1,619,488		2,779,845	1,772,894		1,838,726	2,709,590			
-- Based on Max Flux		2,717,536	1,733,590		1,754,586	1,611,694		2,723,837	1,729,699		1,816,932	2,633,201			
-- Membrane area in service, sf		2,771,653	1,777,953		2,072,197	1,619,488		2,779,845	1,772,894		1,838,726	2,709,590			
- Number of Modules (Elements)		4,264	2,735		6,095	2,492		4,277	2,728		2,829	4,169			
- Number of Cassettes in service (typ.)		533	342		127	312		535	341		354	522			
o Membrane Zone Configuration															
- Total Number of Membrane Zones	*	2	2		8	2		2	2		2	2			
- Cassettes Required per Zone															
-- All units in service		267	171		16	156		268	171		177	261			
-- Allowing for one unit out of service		534	342		18	312		536	342		354	522			
- Cassettes Installed per Zone	*	534	342		18	312		536	342		354	522			
-- Cassettes spaces provided, incl. Spares	*	534	342		22	312	Per Zenon	536	342		354	522			
- Total Membrane Area, all Zones, sf		5,553,600	3,556,800		2,387,383	3,244,800		5,574,400	3,556,800		3,681,600	5,428,800			
- Flux @ Daily Avg Flow, gfd															
-- One Zone OOS		14.0	14.0		17.9	14.0		14.0	14.0		14.0	14.0			
-- All Zones in Service		7.0	7.0		15.6	7.0		7.0	7.0		7.0	7.0			
- Flux @ Peak Flow, gfd															
-- One Zone OOS		17.8	17.7		23.0	18.1		17.8	17.7		18.0	17.7			
-- All Zones in Service		8.9	8.9		20.1	9.0		8.9	8.9		9.0	8.8			
- Freeboard Check (from FB Check section below)															
-- At Peak Flow (AB ***or*** MZ OOS)		OK	OK		OK	OK		OK	OK		OK	OK			
.. 1 AB ***and*** 1 MZ OOS		OK	OK		OK	OK		OK	OK		OK	OK			
-- At Inst. Max Flow (AB or MZ OOS)		Overload	Overload		Overload	Overload		Overload	Overload		Overload	Overload			
.. 1 AB ***and*** 1 MZ OOS		Overload	Overload		Overload	Overload		Overload	Overload		Overload	Overload			
o Membrane Zone Dimensions - per Zone															
- Number of cassettes accommodated		534	342		22	312		536	342		354	522			
- Dimensions Along Length of Cassette:															
-- Zone inside dimension, ft	*	134.4	109.2		19.5	100.8		134.4	109.2		109.2	134.4			
-- Number of Cassette positions	*	17	13		2	12		17	13		13	17			
-- Free space provided [30-50]		32%	40%		37%	40%		32%	40%		40%	32%			
- Dimensions Along Width of Cassette:															
-- Zone inside dimension, ft	*	107.072	90.342		75	86.996		107.072	90.342		93.688	103.726			
-- Number of Cassette positions	*	32	27		11	26		32	27		28	31			
-- Free space provided [30-50]		40%	40%		20%	40%		40%	40%		40%	40%			
- Total Cassette Spaces per Membrane Zone		544	351		22	312		544	351		364	527			
- Side Water Depth at min. flow, ft	*	8.7	8.7		11.9	8.7		8.7	8.7		8.7	8.7			
-- Minimum cassette water cover	*	1	1		1	1		1	1		1	1			
-- Cassette submergence		7.73	7.73		9.3	7.73		7.73	7.73		7.73	7.73			
-- Free depth below cassettes, ft		1	1		2.6	1		1	1		1	1			
o Net Biological Reaction Volume															
- Cassette volume per Zone, cf		59,193	37,910		6,882	34,585		59,415	37,910		39,240	57,863			
- Total membrane zone volume, mil gal		1.88	1.29		1.04	1.15		1.88	1.29		1.34	1.82			
- Total volume occupied by cassettes, mil gal		0.89	0.57		0.41	0.52		0.89	0.57		0.59	0.87			
- Nominal Aer. Basin volume, mil gal		11.12	7.85		5.69	7.85		8.09	7.85		6.07	7.85			
- Available Biological Reaction Volume		10.24	7.29		6.32	7.34		7.20	7.29		5.48	6.99			
o MLSS Relationships															
- Target MLSS in Membrane Zone, mg/L		3,500	2,500		10,000	2,500		3,500	2,500		5,500	4,500			
- Target MLSS in Reaction Zones, mg/L		7,000	7,000		8,000	7,000		7,000	7,000		7,000	7,000			
- Total Recycle Ratio required leaving Zone 7		0.29	0.29		4.00	0.29		0.29	0.29		0.29	0.29			
-- MLR from Zone 7 (only if from Z7)		2.45	1.98		0.00	2.17		2.45	2.00		2.31	1.95			

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
-- Qr/Q		0.00	0.00		4.00	0.00		0.00	0.00		0.00	0.00			
- Actual MLSS in Zone 6, mg/L		3,500	2,499		8,026	2,500		3,500	2,499		5,501	4,499			
o Freeboard Check (Uses Main AB only)															
- Number of Basins that provide Freeboard		12	6		5	6		8	6		6	6			
- Basin surface area, each, sf		8,000	10,000		8,000	10,000		8,000	10,000		8,000	10,000			
- Total Freeboard provided, ft	*	6	6		6	6		6	6		6	6			
-- Min. liquid clearance below top of wall	*	1	1		1	1		1	1		1	1			
-- Freeboard used for control	*	1	1		1	1		1	1		1	1			
-- Freeboard available for accumulation		4	4		4	4		4	4		4	4			
- Freeboard volume available, mil gal															
-- All Aeration Basins in service		2.872	1.795		1.197	1.795		1.915	1.795		1.436	1.795			
-- One Aeration Basin OOS		2.633	1.496		0.957	1.496		1.676	1.496		1.197	1.496			
- Membrane capacity at peak flux, mgd															
-- All membranes in Service		101.08	64.73		65.29	59.06		101.45	64.73		67.01	98.80			
-- One cassette in cleaning		100.98	64.64		64.85	58.96		101.36	64.64		66.91	98.71			
-- One Membrane Zone OOS		50.54	32.37		57.13	29.53		50.73	32.37		33.50	49.40			
o Peak Accumulation at Diurnal Peak Flow															
- Peak Influent Flow, mgd		49.46	31.55		47.99	29.33		49.57	31.48		33.07	47.92			
- Peak Flow duration, h	*	4	4		4	4		4	4		4	4			
- All membranes in Service, Accum. mil gal		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
-- & All Aeration Basins in service															
.. Freeboard used, ft		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
-- & One Aeration Basin OOS															
.. Freeboard used, ft		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
- One cassette in cleaning, Accum. mil gal		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
-- & All Aeration Basins in service															
.. Freeboard used, ft		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
-- & One Aeration Basin OOS															
.. Freeboard used, ft		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
- One Membrane Zone OOS, Accum. mil gal		0.000	0.000		0.000	0.000		0.000	0.000		0.000	0.000			
-- & All Aeration Basins in service															
.. Freeboard used, ft		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
-- & One Aeration Basin OOS															
.. Freeboard used, ft		0.00	0.00		0.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
o Peak Accumulation at Max Instantaneous Flow															
- Peak Influent Flow, mgd		73.68	46.69		72.21	44.47		73.80	46.62		49.72	70.63			
- Peak Flow duration, h	*	4	4		4	4		4	4		4	4			
- All membranes in Service, Accum. mil gal		0.000	0.000		1.153	0.000		0.000	0.000		0.000	0.000			
-- & All Aeration Basins in service															
.. Freeboard used, ft		0.00	0.00		3.85	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		0	0		0	0		0	0			
-- & One Aeration Basin OOS															
.. Freeboard used, ft		0.00	0.00		4.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		195,443	0		0	0		0	0			
- One cassette in cleaning, Accum. mil gal		0.000	0.000		1.227	0.000		0.000	0.000		0.000	0.000			
-- & All Aeration Basins in service															
.. Freeboard used, ft		0.00	0.00		4.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		30,474	0		0	0		0	0			

* Input Data

CAROLLO ENGINEERS, PC
W.O./CLIENT: 7472A.00 / CITY OF RIVERSIDE
PROJECT: REGIONAL WATER QUALITY CONTROL PLANT -
SUBJECT: PROCESS ANALYSIS AND MASS BALANCE
Calc by CFP,NV Date Time 02/27/2008 1:50 PM Chk by/Date FileName: Ch07-AppA.xls
Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
-- & One Aeration Basin OOS															
.. Freeboard used, ft		0.00	0.00		4.00	0.00		0.00	0.00		0.00	0.00			
.. Excess flow to be diverted, gal/d		0	0		269,834	0		0	0		0	0			
- One Membrane Zone OOS, Accum. mil gal		3.858	2.387		2.513	2.491		3.845	2.376		2.703	3.539			
-- & All Aeration Basins in service															
.. Freeboard used, ft		4.00	4.00		4.00	4.00		4.00	4.00		4.00	4.00			
.. Excess flow to be diverted, gal/d		985,244	592,210		1,316,371	695,658		1,930,252	580,406		1,267,106	1,743,497			
-- & One Aeration Basin OOS															
.. Freeboard used, ft		4.00	4.00		4.00	4.00		4.00	4.00		4.00	4.00			
.. Excess flow to be diverted, gal/d		1,224,604	891,410		1,555,731	994,858		2,169,612	879,606		1,506,466	2,042,697			
o Scrubbing Air Requirements															
- Applied air per module, scfm		14.7	14.7		1.3	14.7		14.7	14.7		14.7	14.7			
-- Sufficient for Oxygen Demand? (>)					More Ox reqd										
- Number of modules - all Zones in serv		8,544	5,472		7,022	4,992		8,576	5,472		5,664	8,352			
- Air supply - all Zones in service, scfm		125,986	80,688		9,373	73,610		126,458	80,688		83,519	123,155			
- Air supply - one Zone OOS, scfm		62,993	40,344		8,202	36,805		63,229	40,344		41,760	61,578			
o Oxygen Transfer Efficiency (Coarse Bubble)															
- Diffuser submergence, ft		7.7	7.7		9.3	7.7		7.7	7.7		7.7	7.7			
- Clean Water SOTE, est.		6.3	6.3		7.6	6.3		6.3	6.3		6.3	6.3			
- Equilibrium C*20		9.69	9.69		9.82	9.69		9.69	9.69		9.69	9.69			
-- Adjusted C*20		7.91	7.91		8.01	7.91		7.91	7.91		7.91	7.91			
- OTE Multiplier		0.112	0.116		0.087	0.116		0.112	0.116		0.104	0.108			
- Minimum DO required, mg/L	*	2.00	2.00		1.50	2.00		2.00	2.00		2.00	2.00			
- Membrane Zone D.O., mg/L		**6.93**	**7.13**		**1.50**	**7.17**		**6.88**	**6.89**		**6.82**	**6.99**			
- Site Conditions Adjustment Factor, F		0.11	0.09		0.57	0.09		0.11	0.12		0.11	0.10			
= OTEMult x (C*20adj - C)															
- Est. Oxygen Transfer Efficiency, %		0.69	0.57		4.32	0.54		0.72	0.75		0.71	0.62			
o D.O. Concentration without Air Supplement															
- Ox.Transfer=Biological Demand, lb/d		21,810	11,582		12,182	9,948		22,983	15,185		14,952	19,338			
- Resulting DO conc, mg/L		6.93	7.13		0.25	7.17		6.88	6.89		6.82	6.99			
(All Zones in service)					More Ox rqd!										
o Supplemental Oxygen required															
- Max. (Biological) Ox. Demand, lb/d		21,810	11,582		12,182	9,948		22,983	15,185		14,952	19,338			
- Ox.Transferred from Mem. air, lb/d		21,814	11,584		10,220	9,950		22,987	15,188		14,955	19,342			
- Supplemental Ox requd in Membr zone, lb/d		0	0		1,962	0		0	0		0	0			
o Aeration Diffusers in Membrane Zones															
- Total Floor Area in Membrane Zones, sf		28,781	19,731		11,700	17,538		28,781	19,731		20,461	27,882			
- Floor Area reserved for Cassettes		15,602	10,067		7,123	8,948		15,602	10,067		10,440	15,114			
- Available Free Floor Area, sf		13,179	9,664		4,577	8,590		13,179	9,664		10,022	12,767			
- Total MZ Floor Area fitted with Diffusers, sf	*	0	0		0	0		0	0		0	0			
o Scrubbing Blower Discharge pressure															
- Head, ft water															
-- Submergence (min water level)		7.7	7.7		9.3	7.7		7.7	7.7		7.7	7.7			
-- Freeboard above min. op. level		5.0	5.0		5.0	5.0		5.0	5.0		5.0	5.0			
-- Diffuser head loss	*	0.5	0.5		0.5	0.5		0.5	0.5		0.5	0.5			
-- Pipe & Valve friction	*	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0			
-- Total Head, ft		14.2	14.2		15.8	14.2		14.2	14.2		14.2	14.2			
Discharge pressure @ min. op. level, psig		4.0	4.0		4.7	4.0		4.0	4.0		4.0	4.0			
- Discharge pressure @ pk freeboard, psig		6.2	6.2		6.8	6.2		6.2	6.2		6.2	6.2			
o Delivered Horsepower															
- Max Operating Air Temp, C	*	34	34		34	34		34	34		34	34			
- Barometric Pressure, psia		14.3	14.3		14.3	14.3		14.3	14.3		14.3	14.3			
- Blower Suction Pressure, psia		14.0	14.0		14.0	14.0		14.0	14.0		14.0	14.0			
- Daily Average Total Air, scfm		125,986	80,688		9,373	73,610		126,458	80,688		83,519	123,155			

* Input Data

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		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Avg Delivered Horsepower, hp		2,351	1,506		200	1,374		2,360	1,506		1,558	2,298			
- Peak Freeboard Delivered hp		3,387	2,169		275	1,979		3,400	2,169		2,245	3,311			
o Wire power required															
- Energy Efficiency, %	*	61.0	61.0		61.0	61.0		61.0	61.0		61.0	61.0			Default
- Wire power required, hp															
-- Daily Average		3850	2470		330	2250		3870	2470		2550	3770			
-- Firm Installed		5550	3560		450	3240		5570	3560		3680	5430			
-- Daily Average, kW		2870	1840		240	1680		2880	1840		1900	2810			
-- Firm Installed, kW		4140	2650		340	2420		4150	2650		2740	4040			
o Scrubbing Air Blowers Required															
- Number of Blowers (1 standby)	*	3	3		9	3		3	3		3	3			
- Capacity, each, scfm		63,000	40,400		1,200	36,900		63,300	40,400		41,800	61,600			
- Firm Capacity (duty blowers), scfm		126,000	80,800		9,600	73,800		126,600	80,800		83,600	123,200			
- Blower Motor Size, each, hp		2780	1780		60	1630		2790	1780		1850	2720			
SLUDGE RETURN AND WASTAGE															
o Wasting Method (see Process Layout)															
- Waste Flow from RAS, Qw		0.350	0.369		0.000	0.322		0.222	0.213		0.210	0.459			
- Waste Flow from MLSS, Zone 7, Qmw		0.00	0.00		0.50	0.00		0.00	0.00		0.00	0.00			
o Return Sludge															
- Qr/Q, fraction	*	0.33	0.32		4.00	0.32		0.33	0.32		0.60	0.44			
- RAS flow to Aer Basin, Qr, mgd Average		13.01	7.99		151.33	7.27		13.01	7.91		15.66	16.87			
- RAS concentration, mg/L		13,648	9,936		10,000	9,954		13,781	10,122		14,411	14,342			
o Sludge Wastage															
- Total Solids Wasted, lb/d		41,506	31,392		41,775	27,485		27,098	18,820		26,277	56,195			
- Adjustment for ESS:															
-- Solids in Effluent, lb/d		1,618	830		0	756		1,623	828		1,073	1,265			
-- Solids in WAS, lb/d		39,888	30,562	70,449	41,775	26,728	68,503	25,476	17,992	43,467	25,204	54,929	80,133		
- Concentration, mg/L		13,648	9,936		10,000	9,954		13,781	10,122		14,411	14,342			
- Organic N, lb/d		2,648	2,102		2,755	1,837		1,703	1,199		1,623	3,621			
- Flow Rate, mgd Average		0.350	0.369	0.719	0.501	0.322	0.823	0.222	0.213	0.435	0.210	0.459	0.669		
o WAS Characteristics, mg/L															
- Wasting from -		RAS	RAS		Zone 7	RAS		RAS	RAS		RAS	RAS			
- BOD		3,781	3,059		2,758	2,964		3,863	2,677		3,462	4,137			
- TSS		13,648	9,936		10,000	9,954		13,781	10,122		14,411	14,342			
- VSS		11,508	8,432		8,415	8,454		11,590	8,484		12,066	12,031			
- NH3-N		0.3	0.4		0.2	0.3		0.5	0.9		0.2	0.4			
- Organic-N		906.1	683.5		659.5	684.0		921.4	674.6		927.9	945.4			
- NO3-N		6.7	7.4		7.4	6.6		7.5	7.7		5.4	7.2			
- Alkalinity		141	139		139	142		139	140		146	140			
- Filterable ("soluble") BOD		1.0	1.2		1.1	1.1		1.1	1.1		1.0	1.3			
- Total soluble Organic N		2.3	2.4		2.3	2.3		2.3	2.4		2.3	2.4			
o Recommended Installed Capacity															
- Return Sludge Pumps, gpm		27,170	17,530		69,190	15,960		27,160	17,370		18,010	26,650			
- WAS Pumps															
-- Wasting operation, hr/day	*	24	24	24	24	24	24	24	24	24	24	24	24		
-- Pump Capacity (2 x Qwas), gpm		490	520	1,000	700	450	1,150	310	300	610	300	640	930		
-- WAS Solids Peak Handling Capacity, lb/hr		3,330	2,550	5,880	3,490	2,230	5,710	2,130	1,500	3,630	2,110	4,580	6,680		
SECONDARY EFFLUENT															
o Flow Rate															
- Net Secondary Effluent, mgd		38.80	24.89	63.69	37.33	22.67	60.00	38.92	24.82	63.74	25.74	37.93	63.68		
o Secondary Effluent Quality															
- BOD, mg/L		2	2	2.0	1	2	1.6	2	2	2.0	2	2	2.0		Estimate

* Input Data

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		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	info	
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- TSS (nominal), mg/L	*	5	4	4.4	0	4	2.4	5	4	4.4	5	4	4.4		Default
- VSS, mg/L		4.2	3.4	3.7	0.0	3.4	2.1	4.2	3.4	3.7	4.2	3.4	3.7		
- NH3-N, mg/L		0.3	0.4	0.3	0.2	0.3	0.3	0.5	0.9	0.7	0.2	0.4	0.3		
- Total Organic N, mg/L		2.7	2.7	2.7	2.3	2.6	2.5	2.7	2.6	2.6	2.6	2.7	2.7		
- NO3/NO2-N, mg/L		6.7	7.4	7.1	7.4	6.6	6.9	7.5	7.7	7.6	5.4	7.2	6.5		
- Alkalinity, mg/L		141	139	140	139	142	141	139	140	139	146	140	142		
- Soluble Organic N, mg/L		2.3	2.4	2.4	2.3	2.3	2.3	2.3	2.4	2.4	2.3	2.4	2.4		
- T.I.N., mg/L		7.0	7.8	7.5	7.6	6.9	7.2	8.0	8.6	8.3	5.6	7.7	6.8		
- Total N, mg/L		9.7	10.5	10.2	9.9	9.4	9.6	10.6	11.2	11.0	8.2	10.4	9.5		
TERTIARY FILTRATION				In Service		In Service	Plant 2 (conv) only			In Service			In Service		
o Tertiary Filtration in Service? (Y=1, N=0)	*			1		1				1			1		
o Influent															
- Flow, mgd															
-- Total				63.7		22.7				63.7			63.7		
- BOD, total, mg/L				2.0		2.0				2.0			2.0		
- SS, total, mg/L				4.4		4.0				4.4			4.4		
o Filter Area															
- Surface Area per Filter, sf	*			200		200				200			200		
- Backwash - Continuous (0) or Intermittent (1)?	*			0		0				0			0		
- Standby Units Provided	*			2		2				2			2		
- Number of Filters															
-- Existing	*			16		16				16			16		
-- New	*			0		0				0			0		
-- Total				16		16				16			16		
- Number of Units in Service				14		14				14			14		
o Filter Loading															
- Equalization provided? (Y=1, N=0)	*			1		1				1			1		
- Peaking factor	*			1.10		1.10				1.10			1.10		Default
- Surface Area in Service, sf				2,800		2,800				2,800			2,800		
- Loading rate, gpm/sf				17.4		6.2				17.4			17.4		
o Removal															
- SS Removal, %	*			70		70				70			70		Default
- SS removed, lb/d				1,634		529				1,635			1,634		
- BOD removed, lb/d				328		119				334			317		
o Backwash Flow															
- Percent of Flow, %	*			9		9				9			9		Cont BW
- Backwash Flow, mgd				5.73		2.04				5.74			5.73		
o Backwash Characteristics, mg/L															
- BOD				8		8				8			8		
- TSS				34		31				34			34		
- VSS				29		26				29			29		
- NH3-N				0.3		0.3				0.7			0.3		
- Organic-N				5		4				5			5		
- NO3-N				7.1		6.6				7.6			6.5		
- Alkalinity				140		142				139			142		
o Net Flow to Disinfection, mgd															
- Undisinfected Plant Water Used	*			0.00		0.00				0.00			0.00		
- To Disinfection				57.96		20.63				58.00			57.95		
o Tertiary Effluent Quality, mg/L															
- BOD				1.4		1.4				1.4			1.4		
- SS				1.3		1.2				1.3			1.3		
- VSS, mg/L				1.1		1.0				1.1			1.1		
- NH3-N, mg/L				0.3		0.3				0.7			0.3		

* Input Data

CAROLLO ENGINEERS, PC

W.O./CLIENT:	7472A.00 / CITY OF RIVERSIDE
PROJECT:	REGIONAL WATER QUALITY CONTROL PLANT -
SUBJECT:	PROCESS ANALYSIS AND MASS BALANCE

Calc by: CFP,NV Date Time: 02/27/2008 1:50 PM Chk by/Date FileName: Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	info	
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Total Organic N, mg/L				2.5			2.4			2.4			2.5		
- NO3/NO2-N, mg/L				7.1			6.6			7.6			6.5		
- Alkalinity, mg/L				140			142			139			142		
- Filterable ("soluble") BOD				1.1			1.1			1.1			1.1		
- Soluble Organic N, mg/L				2.4			2.3			2.4			2.4		
- T.I.N., mg/L				7.5			6.9			8.3			6.8		
- Total N, mg/L				10.0			9.2			10.8			9.3		
CHLORINE CONTACT TANKS				In Service			In Service			In Service			In Service		
o Flow Rate, mgd				57.96			57.96			58.00			57.95		
- Peaking factor	*			1.1			1.1			1.1			1.1		
o Number of Tanks	*			4			4			4			4		
o Volume per Tank, mil gal	*			1.327			1.327			1.328			1.327		
o Detention Time @ peak, min.				120			120			120			120		
FINAL EFFLUENT															
o Flow Rate, mgd															
- Plant Water used	*			0.12			0.12			0.16			0.11		
- Final Effluent Flow				57.84			57.84			57.84			57.84		
RESIDUALS MANAGEMENT															
SOLIDS GENERATED															
o Total Primary Sludge															
- Flow, mgd		1.515	0.954	2.468	1.586	0.908	2.494	1.986	1.252	3.237	0.980	1.220	2.200		
- Solids, lb/d		63,163	39,762	102,925	66,122	37,882	104,003	82,809	52,188	134,997	40,860	50,873	91,734		
- Concentration, %		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5		
- VSS, %		81	81	81	81	81	81	78	78	78	81	81	81		
- Organic N, lb/d		2,654	1,670	4,323	2,757	1,592	4,349	3,263	2,054	5,317	1,723	2,150	3,874		
o Total Waste Activated Sludge															
- Flow, mgd		0.350	0.369	0.719	0.501	0.322	0.823	0.222	0.213	0.435	0.210	0.459	0.669		
-- Recomm Installed Capacity, gpm		490	520	1,000	700	450	1,150	310	300	610	300	640	930		
- Solids, lb/d		39,888	30,562	70,449	41,775	26,728	68,503	25,476	17,992	43,467	25,204	54,929	80,133		
-- Recomm Installed Capacity, lb/hr		3,330	2,550	5,880	3,490	2,230	5,710	2,130	1,500	3,630	2,110	4,580	6,680		
- Concentration, mg/L		13,648	9,936	11,745	10,000	9,954	9,982	13,781	10,122	11,988	14,411	14,342	14,364		
- VSS, %		84	85	85	84	85	84	84	84	84	84	84	84		
- Organic N, lb/d		2,648	2,102	4,750	2,755	1,837	4,592	1,703	1,199	2,902	1,623	3,621	5,244		
- BOD/TSS ratio		0.28	0.31	0.29	0.28	0.30	0.28	0.28	0.26	0.27	0.24	0.29	0.27		
WAS THICKENING				In Service			In Service			In Service			In Service		
o Sludge Feed															
- Flow, mgd				0.719			0.823			0.435			0.669		
- Solids, lb/d				70,449			68,503			43,467			80,133		
- Concentration, mg/L				11,745			9,982			11,988			14,364		
- VSS, %				85			84			84			84		
- Organic N, lb/d				4,750			4,592			2,902			5,244		
- Solids BOD, lb/d				20,452			19,470			11,895			21,894		
- NH3-N, mg/L				0.3			0.3			0.7			0.3		
- NO3-N, mg/L				7.1			6.9			7.6			6.5		
- Alkalinity				140			141			139			142		
- Filterable ("soluble") BOD, mg/L				1.1			1.1			1.1			1.1		
- Soluble OrgN, mg/L				2.4			2.3			2.4			2.4		
-- N/VSS ratio for solids				0.080			0.079			0.080			0.078		
o Number of Units	*			4			4			4			4		
- Number of Units in Service	*			4			4			4			4		

* Input Data

CAROLLO ENGINEERS, PC

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Calc by: CFP,NV Date Time: 02/27/2008 1:50 PM Chk by/Date FileName: Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	info	
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Diameter, ft	*			37			37			37			37		
- Effective Area in Service, sf				3,959			3,959			3,959			3,959		
- Operating cycle, hr/week	*			168			168			168			168		Default
o Hydraulic loading, gpm/sf				0.29			0.30			0.18			0.30		
o Solids Loading, lb/d-sf				17.8			17.3			11.0			20.2		
o Thickened Sludge															
- Solids Capture, %	*			95			95			95			95		
- Solids, lb/d				66,927			65,078			41,294			76,126		
- Percent Solids, %	*			**6.0 GBT**			**6.0 GBT**			**6.0 GBT**			**6.0 GBT**		
- Volume, mgd				0.134			0.130			0.083			0.152		
- Volatile Solids, lb/d				56,588			54,960			34,681			63,820		
- Organic N, lb/d				4,516			4,365			2,759			4,985		
o Underflow															
- Underflow solids, lb/d				3,522			3,425			2,173			4,007		
- Flow, mgd				0.585			0.693			0.352			0.517		
- Characteristics, mg/L															
-- BOD				211			170			204			255		
-- TSS				721			593			740			930		
-- VSS				610			501			621			779		
-- NH3-N				0.3			0.3			0.7			0.3		
-- Organic-N				48			39			49			60		
-- NO3-N				7.1			6.9			7.6			6.5		
-- Alkalinity				140			141			139			142		
ANAEROBIC DIGESTION				In Service			In Service			In Service			In Service		
o Digester Feed															
- Flow, total, mgd				0.309			0.307			0.312			0.308		
- Solids, total, lb/d				154,413			153,481			156,042			154,100		
- Volatile Solids, total, lb/d				127,422			126,530			124,238			126,950		
- Organic N, total, lb/d				8,190			8,061			7,278			8,277		
o - Anaerobic Digestion Type															
o Acid Phased Anaerobic Digestion				In-Service			In-Service			In-Service			In-Service		
o FIRST SET OF DIGESTERS IN SERIES															
o Digester Size															
- Smaller Size Units															
-- Number	*			1			1			1			1		
-- Diameter, ft	*			60			60			60			60		
-- SWD, ft	*			28.5			28.5			28.5			28.5		
-- Volume per Digester, kcf				80.6			80.6			80.6			80.6		
-- Volume per Digester, mg				0.60			0.60			0.60			0.60		
- Larger Size Units															
-- Number	*			0			0			0			0		
-- Diameter, ft	*			70			70			70			70		
-- SWD, ft	*			29			29			29			29		
-- Volume per Digester, kcf				111.6			111.6			111.6			111.6		
-- Volume per Digester, mg				0.83			0.83			0.83			0.83		
- Gross Volume, kcf															
-- All Units in Service				80.6			80.6			80.6			80.6		
...Largest digester				80.6			80.6			80.6			80.6		
-- One Unit OOS				0.0			0.0			0.0			0.0		
- Allowance for grit, percent	*			5			5			5			5		
- Effective Volume, kcf															

* Input Data

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Calc by	Date Time	Chk by/Date	FileName:
CFP,NV	02/27/2008 1:50 PM		Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
-- All Units in Service				77			77			77			77		
-- One Unit OOS				0			0			0			0		
o Loading															
- VSS Loading, lb VSS/cf-d															
-- All Units in Service				1.7			1.7			1.6			1.7		
-- One Unit OOS				#DIV/0!			#DIV/0!			#DIV/0!			#DIV/0!		
- Detention Time, days															
-- All Units in Service				1.86			1.87			1.84			1.86		
-- One Unit OOS				0.0			0.0			0.0			0.0		
o SECOND SET OF DIGESTERS IN SERIES															
o Digester Size															
- Smaller Size Units															
-- Number	*			2			2			2			2		
-- Diameter, ft	*			90			90			90			90		
-- SWD, ft	*			32			32			32			32		
-- Volume per Digester, kcf				203.6			203.6			203.6			203.6		
-- Volume per Digester, mg				1.52			1.52			1.52			1.52		
- Larger Size Units															
-- Number	*			1			1			1			1		
-- Diameter, ft	*			88			88			88			88		
-- SWD, ft	*			38			38			38			38		
-- Volume per Digester, kcf				231.1			231.1			231.1			231.1		
-- Volume per Digester, mg				1.73			1.73			1.73			1.73		
- Gross Volume, kcf															
-- All Units in Service				638.3			638.3			638.3			638.3		
...Largest digester				231.1			231.1			231.1			231.1		
-- One Unit OOS				407.2			407.2			407.2			407.2		
- Allowance for grit, percent	*			5			5			5			5		
- Effective Volume, kcf															
-- All Units in Service				606			606			606			606		
-- One Unit OOS				387			387			387			387		
o Loading															
- VSS Loading, lb VSS/cf-d															
-- All Units in Service				0.21			0.2			0.2			0.2		
-- One Unit OOS				0.33			0.3			0.3			0.3		
- Detention Time, days															
-- All Units in Service				14.70			14.79			14.54			14.73		
-- One Unit OOS				9.4			9.4			9.3			9.4		
o Temperature, deg C	*			35			35			35			35		
o THIRD SET OF DIGESTERS IN SERIES															
o Digester Size															
- Smaller Size Units															
-- Number	*			1			1			1			1		
-- Diameter, ft	*			75			75			75			75		
-- SWD, ft	*			32			32			32			32		
-- Volume per Digester, kcf				141.4			141.4			141.4			141.4		
-- Volume per Digester, mg				1.06			1.06			1.06			1.06		
- Larger Size Units															
-- Number	*			0			0			0			0		
-- Diameter, ft	*			90			70			70			70		
-- SWD, ft	*			29			29			29			29		
-- Volume per Digester, kcf				184.5			111.6			111.6			111.6		
-- Volume per Digester, mg				1.38			0.83			0.83			0.83		
- Gross Volume, kcf															

* Input Data

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
-- All Units in Service				141.4			141.4			141.4			141.4		
...Largest digester				141.4			141.4			141.4			141.4		
-- One Unit OOS				0.0			0.0			0.0			0.0		
- Allowance for grit, percent	*			5			5			5			5		
- Effective Volume, kcf															
-- All Units in Service				134			134			134			134		
-- One Unit OOS				134			134			134			134		
o Loading															
- VSS Loading, lb VSS/cf-d															
-- All Units in Service				0.949			0.942			0.925			0.945		
-- One Unit OOS				0.949			0.942			0.925			0.945		
- Detention Time, days															
-- All Units in Service				3.26			3.28			3.22			3.26		
-- One Unit OOS				3.3			3.3			3.2			3.3		
o Digestion Summary															
- Temperature, deg C	*			35			35			35			35		
- All units in service															
-- Total Volume, mg				6.1			6.1			6.1			6.1		
-- Combined SRT, days				19.8			19.9			19.6			19.8		
- Largest Unit out of service															
-- Largest Digester, mg				1.64			1.64			1.64			1.64		
-- Combined SRT, days				14.5			14.6			14.3			14.5		
o Acid Phase Assumptions															
- Acid Phase Cut Off, days	*			5			5			5			5		
- Additoinal biodegradability of WAS, %	*			0			0			0			0		
o VS Reduction for the First Set of Digests In Series															
- Acid Phase or Methane Phase?				acid			acid			acid			acid		
- Primary Sludge VSS, ppd				70,834			71,570			89,557			63,130		
-- % Degradable	*			71			71			67			71		
-- Inerts, ppd				20,224			20,441			29,491			18,027		
-- Degradable Solids, ppd				50,610			51,129			60,066			45,103		
-- VSS destruction %				27			27			25			27		
-- VS Destroyed, ppd				19,076			19,344			22,493			17,022		
- WAS VSS, ppd				56,588			54,960			34,681			63,820		
-- Aeration Basin Aerobic SRT, days				7.2			7.9			9.2			8.2		
-- % Degradable				56			55			54			55		
-- Inerts, ppd				24,789			24,486			16,007			28,660		
-- Degradable Solids, ppd				31,799			30,474			18,674			35,160		
-- VSS destruction %				21			21			20			21		
-- VS Destroyed				11,986			11,530			6,993			13,269		
- Total VSS destruction, %				24			24			24			24		
-- T * SRT (deg C*days)				65			65			64			65		
-- VSR check, %				NA			NA			NA			NA		
- VSS destroyed, lb/d				26,989			26,544			25,050			26,395		
- Discharge Total Solids, lb/d				127,424			126,936			130,992			127,705		
- Discharge Volatile Solids, lb/d				100,433			99,986			99,188			100,555		
-- TSS, %				5.0			5.0			5.0			5.0		
-- VSS, %				78.8			78.8			75.7			78.7		
o Gas Production															
- cf/lb VSS destroyed	*			4			4			4			4		
- Gas Production, kcf/d				108			106			100			106		
- BTU/cf	*			130			130			130			130		
- MMBTU/hr				0.6			0.6			0.5			0.6		
o VS Reduction for the Second Set of Digests In Series															

* Input Data

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Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Acid Phase or Methane Phase?				methane			methane			methane			methane		
- Remaining Primary Sludge VSS, ppd				51,758			52,226			67,064			46,108		
-- % Degradable				61			61			56			61		
-- VSS destruction %				50			50			46			50		
-- VS Destroyed				26,089			26,324			31,030			23,241		
- Remaining WAS VSS, ppd				44,602			43,430			27,688			50,551		
-- % Degradable				44			44			42			43		
-- VSS destruction %				37			36			35			36		
-- VS Destroyed				16,392			15,690			9,647			18,117		
- Total VSS destruction, %				42			42			41			41		
- VSS destroyed, lb/d				42,482			42,014			40,676			41,358		
- Discharge Total Solids, lb/d				84,942			84,923			90,316			86,347		
- Discharge Volatile Solids, lb/d				57,951			57,973			58,512			59,197		
-- TSS, %				3.3			3.3			3.5			3.4		
-- VSS, %				68.2			68.3			64.8			68.6		
o Gas Production															
- cf/lb VSS destroyed	*			22			22			22			22		
- Gas Production, kcf/d				935			924			895			910		
- BTU/cf	*			670			670			670			670		
- MMBTU/hr				26.1			25.8			25.0			25.4		
o VS Reduction for the Third Set of Digests In Series															
- Acid Phase or Methane Phase?				methane			methane			methane			methane		
- Remaining Primary Sludge VSS, ppd				25,669			25,902			36,035			22,867		
-- % Degradable				21			21			18			21		
-- VSS destruction %				11			11			9			11		
-- VS Destroyed				2,803			2,820			3,352			2,495		
- Remaining WAS VSS, ppd				28210			27741			18042			32434		
-- % Degradable				12			12			11			12		
-- VSS destruction %				6			6			6			6		
-- VS Destroyed				175			171			194			150		
- Total VSS destruction, %				5			5			6			4		
- VSS destroyed, lb/d				2,978			2,991			3,546			2,644		
- Discharge Total Solids, lb/d				81,964			81,932			86,770			83,703		
- Discharge Volatile Solids, lb/d				54,973			54,982			54,966			56,553		
-- TSS, %				3.2			3.2			3.3			3.3		
-- VSS, %				67.1			67.1			63.3			67.6		
o Gas Production															
- cf/lb VSS destroyed	*			15			15			15			15		
- Gas Production, kcf/d				45			45			53			40		
- BTU/cf	*			615			615			615			615		
- MMBTU/hr				1.1			1.1			1.4			1.0		
o Digestion Summary															
- Total VSS destroyed, lb/day				72,449			71,548			69,272			70,397		
- Total VSS destruction, %		37		**57**	37		**57**	37		**56**	37		**55**		
- Temp * SRT				693			698			686			695		
- Total Gas Production, kcf/d				1087			1075			1048			1055		
-- Overall rate, cf/lb VSS destroyed				15.0			15.0			15.1			15.0		
- Total Energy Production, mmBTU/hr				28			28			27			27		
-- Overall rate, BTU/cf				614			614			616			614		
o Nitrogen in Dig Sludge Filtrate															
- Assumed Sol OrgN in Digester effl, mg/L				5			5			5			5		
-- lb/d				12.9			12.79			13.00			12.84		
- Org N/VSS (VSS of digester feed) in Digester Solids				0.064			0.064			0.058			0.065		
- VSS destroyed, lb/d				72,449			71,548			69,272			70,397		

* Input Data

CAROLLO ENGINEERS, PC

W.O./CLIENT:	7472A.00 / CITY OF RIVERSIDE
PROJECT:	REGIONAL WATER QUALITY CONTROL PLANT -
SUBJECT:	PROCESS ANALYSIS AND MASS BALANCE

Calc by: CFP,NV Date Time: 02/27/2008 1:50 PM Chk by/Date FileName: Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
- Ammonia generated (organic N released), lb/d				4,650			4,551			4,051			4,583		
- Organic N taken up by struvite, lb/d				0			0			0			0		
- NH3 Concentration, mg/L				1,807			1,779			1,558			1,784		
- Alkalinity, mg/L				6,452			6,354			5,563			6,373		
DEWATERING (Belt Presses)				N.I.S.			N.I.S.			N.I.S.			N.I.S.		
o Sludge Feed															
- Flow rate, mgd	*			0.309			0.307			0.312			0.308		
- Total Solids, lb/d	*			81,964			81,932			86,770			83,703		
- Total VSS, lb/d	*			54,973			54,982			54,966			56,553		
o Number of Belt Presses (2m)	*			0			0			0			0		
- Number of Units in Service	*			0			0			0			0		
- Feed Rate, gpm per unit	*			110			110			110			110		Default
- Operating cycle															
-- days/week	*			6			6			6			6		
-- hours/day (calc)				0.0			0.0			0.0			0.0		
o Sludge Cake															
- Capture, %	*			90			90			90			90		Default
- Concentration, %	*			16.23			16.38			19.24			15.25		Default
- Cake Solids, lb/d															
-- Dry Solids, lb/d				81,964			81,932			86,770			83,703		
-- Wet Cake, tons/d				N.I.S.			N.I.S.			N.I.S.			N.I.S.		
- Flow, mgd				0.309			0.307			0.312			0.308		
o Filtrate															
- Filtrate Flow, mgd				0.000			0.000			0.000			0.000		
- Characteristics, mg/L															
-- BOD	*			700			700			700			700		Default
-- TSS	*			250			250			250			250		Default
-- VSS				168			168			158			169		
-- NH3-N				1,807			1,779			1,558			1,784		
-- Organic-N				16			16			14			16		
-- NO3-N				0			0			0			0		
-- Alkalinity				5,414			5,394			5,196			5,303		
o Wash Water															
- Wash water, mgd/mgd feed	*			1.00			1.00			1.00			1.00		Default
-- Wash Water flow, mgd				0.000			0.000			0.000			0.000		
- Solids in Wash Water															
-- Unrecovered Solids, lb/d				0			0			0			0		
-- Solids in Filtrate				0			0			0			0		
-- Solids in Wash Water, lb/d				0			0			0			0		
-- TSS in Wash Water, mg/L				0			0			0			0		
- Characteristics, mg/L															
-- BOD				2			2			2			2		
-- TSS				0			0			0			0		
-- VSS				0			0			0			0		
-- NH3-N				0.0			0.0			0.2			0.0		
-- Organic-N				2			2			2			2		
-- NO3-N				7.1			6.9			7.6			6.5		
-- Alkalinity				140			141			139			142		
-- Filterable ("soluble") BOD				1.1			1.1			1.1			1.1		
-- Total soluble Organic N				2.4			2.3			2.4			2.4		
o Combined Filtrate & Wash Water															
- Flow, mgd															
-- Filtrate				0.000			0.000			0.000			0.000		

* Input Data

CAROLLO ENGINEERS, PC

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PROJECT:	REGIONAL WATER QUALITY CONTROL PLANT -
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Calc by	Date Time	Chk by/Date	FileName:
CFP,NV	02/27/2008 1:50 PM		Ch07-AppA.xls

Biotran05 v.1106

		Design Capacity (Conv. ASP)-high SRT			Design Capacity (MBR)			Design Capacity (EPT)			Design Capacity (Conv. IFAS)-high SRT			Setup info	Basis
		Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined	Plant 1	Plant 2	Combined		
Annual Average Plant Flow, mgd	*	32.0	20.0	52.0	32.0	20.0	52.0	32.0	20.0	52.0	22.0	30.0	52.0		
Design (Max-Month) Flow, mgd		35.5	22.2	57.7	35.5	22.2	57.7	35.5	22.2	57.7	24.4	33.3	57.7		
-- Wash Water				0.000			0.000			0.000			0.000		
-- Total				0.000			0.000			0.000			0.000		
- Characteristics, mg/L															
-- BOD				0			0			0			0		
-- TSS				0			0			0			0		
-- VSS				0			0			0			0		
-- NH3-N				0			0			0			0		
-- Organic-N				0			0			0			0		
-- NO3-N				0			0			0			0		
-- Alkalinity				0			0			0			0		
-- Filterable ("soluble") BOD				0			0			0			0		
-- Total soluble Organic N				0.0			0.0			0.0			0.0		
CENTRIFUGE DEWATERING/THICKENING				In Service			In Service			In Service			In Service		
o Application				Anaerobic Dig Dewat			Anaerobic Dig Dewat			Anaerobic Dig Dewat			Anaerobic Dig Dewat		
o Sludge Feed															
- Flow Rate, mgd				0.309			0.307			0.312			0.308		
- TSS, %				3.18			3.20			3.34			3.26		
- Solids, lb/d				81,964			81,932			86,770			83,703		
-- VSS fraction				0.67			0.67			0.63			0.68		
o Number of Centrifuges	*			3			3			3			3		
- Number of Units in Service				2			2			2			2		
- Feed Rate, gpm per unit	*			250			250			250			250		
- Operating cycle															
-- days/week	*			6			6			6			6		
-- hours/day (calc)				12.0			11.9			12.1			12.0		
o Chemical Dose															
- Ferric chloride, lb/ton	*			0			0			0			0		
- Ferric chloride, lb/day				0			0			0			0		
- Polymer, lb/ton	*			16			16			16			16		
- Polymer, lb/day				635			635			672			649		
- Chemical Sludge generated, lb/d				0			0			0			0		
o Sludge Cake															
- Capture, %	*			95			95			95			95		Default
- Cake Solids, lb/d				77,866			77,836			82,432			79,518		
- Concentration, %	*			24.9			25.0			27.5			23.6		Default
- Flow, mgd				0.0374			0.0373			0.0360			0.0405		
o Filtrate															
- Filtrate Flow, mgd				0.271			0.269			0.276			0.268		
- Characteristics, mg/L															
-- BOD	*			500			500			500			500	230	Default
-- TSS				1,812			1,823			1,886			1,876	250	
-- VSS				1,215			1,224			1,195			1,267	208	
-- NH3-N	*			1,807			1,779			1,558			1,784	23	
-- Organic-N	*			83			83			75			88	14	
-- NO3-N	*			0			0			0			0	0	
-- Alkalinity	*			6,452			6,354			5,563			6,373	250	
-- Fpv, VSS fraction				0.67			0.67			0.63			0.68	0.83	
-- Fvu, Fraction VSS that is Unbiodeg				**0.70**			**0.70**			**0.70**			**0.70**	0.350	
-- D.O. Concentration, mg/L				0			0			0			0	1.0	

* Input Data